Final Report

Commuter Rail Extension Feasibility Study

Framingham to Worcester, Milford & Marlborough

Submitted to

Massachusetts Bay Transportation Authority

Submitted by

Stone & Webster Civil & Transportation Services, Inc.

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in association with

- **Multisystems, Inc.**
- **Rizzo Associates, Inc.**
- **Stull and Lee, Inc.**
- **Transportation and Distribution Associates, Inc.**

EXECUTIVE SUMMARY

The Proposed Service Restoration

Commuter rail service to Worcester, and Milford was terminated in 1975, and 1959 respectively. Service on the Marlborough line was discontinued in two stages; service west of Marlborough junction ceased in 1931 and from Marlborough to Framingham in 1937. In the last 10 years, meanwhile, ridership on the MBTA's commuter rail network has grown by over 60 percent as a network extension to Needham, the Southwest corridor project and numerous other rehabilitation and upgrading projects have been completed.

With limited exceptions, these railroad rights of way continue to exist and carry freight services. In order to maximize use of these resources, the MBTA was asked to study the restoration of service to Worcester. This was later augmented to include examination of service to Milford via the Holliston Industrial Line (formerly the Pink Granite Line) and service to Marlborough via the Framingham Secondary/Fitchburg Secondary lines.

All the potential commuter rail restoration projects studied would function as an extension of the current service to Framingham. Options considered in this report include restoration of an existing 22.9 mile long segment to Worcester near I-290, 12.3 mile segment to Milford near I-495/routes 16 and 109, and a 10.3 mile segment to Marlborough near I-495. For reasons detailed in the report, including relatively high capital investment requirements, low ridership and duplication of service to Milford already planned for the Franklin Line, service on the Holliston Industrial Line is not recommended for implementation.

For purposes of the study, the operating strategy assumed conforms to current MBTA practice of 30 minute headways in the peak and 120 minutes in the off peak hours. Rail facilities would be brought up to full MBTA standards relative to track, signals, passing sidings, grade crossing protection and fencing of the right of way. In addition, standard station canopies, low level and high level access platforms and parking facilities would be provided to meet forecast levels of ridership. New bi-level passenger coaches and new generation MBTA diesel locomotives would be used, with layover facilities sufficient for overnight storage of four train sets for each line.

The Service Area

The region potentially served by the Worcester, Milford and Marlborough extensions includes those communities directly served by the rail lines as well as nearby towns whose commuting residents would also benefit.

Worcester Line - Towns directly served by this extension include Ashland, Westborough, Grafton and Worcester where stations are proposed. In the event that an extension south of Worcester to the Massachusetts Turnpike is developed in the future, a station in Millbury would also receive direct service. The Ashland station would likely be used by riders from Ashland, Holliston and Hopkinton. The Westborough station, in proximity to

I-495 and the Massachusetts Turnpike, would draw riders from Westborough, Marlborough, and Southborough as well as Shrewsbury, Upton and Northborough. The Grafton station would serve patrons from Grafton, Oxford, Shrewsbury, and Charlton. The Worcester station would serve Worcester, Auburn, Millbury, Boylston, West Boylston, Sutton and Spencer. In 1987, 2800 work trips were made from all these towns to downtown Boston, with an increase to 4130 trips projected for the 2010 horizon year.

Existing bus transportation services for commuters in this service area are reasonably good. Peter Pan Bus Lines (a private carrier) provides non-stop service from its terminal in downtown Worcester to its terminal near South Station at hourly headways all day, with additional trips in the peak period which results in 30 minute headways. Limited additional service operates along Route 9. This includes two semi-express trips which serve Worcester, Shrewsbury, Northborough, Westborough, Southborough and Framingham from where it operates express to Boston on the Mass. Turnpike. Finally, local service is offered at 90-120 minute intervals along Route 9 from Worcester to Boston.

Milford Line - Towns directly served by this extension include Holliston, East Holliston and Milford in which stations are proposed. The Holliston station would likely be used by riders from Holliston only. The East Holliston station would draw riders from Holliston and Millis. The Milford station would serve patrons from Upton and Milford. In 1987, 650 work trips were made from these towns to Boston, with an increase to 930 trips projected for the 2010 horizon year.

Existing bus service to Milford consists of two private carriers providing service from Milford to Boston. Brush Hill Transportation operates three peak trips to Boston in the morning with three return trips in the evening. This service operates over Routes 109, 128 and I-90. Intermediate communities served include Medway, Millis, Medfield, and Westwood. The other carrier serving Milford is Big W Transportation, which operates through Ashland, Holliston and Hopkinton to Framingham. However, this service is only operated at infrequent intervals Monday through Saturday.

Marlborough Line - Towns directly served by this extension include the north and western areas of Framingham, and Southborough in which stations are proposed. The two Framingham stations would be used by commuters from Framingham, Sudbury and Westborough. The Southborough Center station would likely serve local residents only. The Southborough station in proximity to I-495 would serve Marlborough, Hopkinton, Northborough, Southborough, Hudson and Berlin. In 1987, 4670 work trips were made from these towns to Boston and travel is projected to increase by 42 percent for a total of 6640 work trips in 2010.

Existing bus transportation services are provided by two private carriers, Big W Transportation and Gulbankian Bus Lines. Big W operates one morning inbound and one afternoon outbound trip along Route 20 serving Marlborough, Wayland, Sudbury and Weston and then express to Boston. Gulbankian provides three round trips per day, in the morning, mid-day and afternoon peak periods between Hudson, Marlborough, Southborough and Boston along Routes 85, 9 and the Massachusetts Turnpike.

Alternative Operating Plans

Currently, four locomotive hauled, train sets in 5 and 6 cars consists are used to provide 30 minute peak direction, peak period service with 120 minute headways in the midday and evening off peak periods. A running time of 50 minutes for local trains is achieved from Framingham to Boston.

This study focused on determining the feasibility and relative attractiveness of extending service in the three rail corridors. In order to meet these objectives, 5 alternatives, one bus and four rail, were configured to generate the information required to examine each corridor alone or in combination. A brief synopsis of these alternatives, is provided below:

TABLE 1
DEFINITION OF ALTERNATIVES

	Peak Headway Service Type			
Corridor	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Framingham to Worcester	30E	30E	---	---
Framingham to Milford	---	30L	30E/L*	---
Framingham to Marlborough	---	---	30E/L*	30E
Framingham to Boston	30E 30L	30E 30L	30E 30L	30E 30L

E = Express from Framingham to Back Bay
L = Local from Framingham to Back Bay
* Trains on these lines would alternate between express and local

Alternative 1: Worcester Service - The first alternative considered includes a 30 minute peak headway Worcester express service to supplement the existing 30 minute peak headway local service to Framingham. The Framingham service is scheduled to duplicate the current arrival times at South Station, with inbound Worcester express trains departing Framingham 5 minutes earlier and arriving at South Station 15 minutes earlier. In the midday and evening off peak, Worcester trains run local all the way to South Station on 120 minute headways.

Alternative 2: Worcester and Milford Service - The second alternative basically extends the current Framingham local trains another 12 miles/25 minutes further to Milford, but keeps the same arrival pattern at South Station. The Worcester service is identical to that in Alternative 1 and departs 5 minutes earlier from Framingham arriving 15 minutes earlier than the Milford local. Off peak midday and evening service comprises 120 minute headway local through service to Worcester coupled with shuttle service between Framingham and Milford. When compared to Alternative 1, this alternative allows the incremental costs, ridership and environmental consequences of the Milford line to be assessed.

Alternative 3: Marlborough and Milford Service - The third alternative substitutes Marlborough for the Worcester line and alters the stopping pattern in the peak to provide alternating local and express service on 30 minute headways in each corridor. When an express operates over the Marlborough line, a local operates over the Milford line and vice versa. Off peak midday and evening service comprises 120 minute headway local through service on the Marlborough line and shuttle service on the Milford line. When compared to Alternative 2, the merits of the Marlborough line relative to the Worcester line can be judged, albeit slightly confounded by the altered local/express stopping pattern.

Alternative 4: Marlborough Service - The fourth rail alternative is similiar to Alternative 1, but substitutes a Marlborough express for the Worcester express in Alternative 1. Thus, 30 minute peak express headways and 120 minute off peak local headways are configured for the Marlborough line while 30 minute peak local headways operate from Framingham to Boston. When compared to Alternative 3, this alternative affords another estimate of the Milford line's incremental results to be observed. Similarly, when Alternative 4 is compared to Alternative 1, the relative merits of a Marlborough vs. Worcester express service overlain on current Framingham local service can be evaluated.

Bus Alternative - In the absence of a commuter rail extension, bus improvements would be required to accommodate the growing number of trips to downtown Boston. For purposes of generating numbers against which to compare the incremental cost effectiveness of the alternative rail investments, the existing private carrier bus services were modified to improve headways in Table 2 on the following page:

TABLE 2
PROPOSED BUS SERVICE IMPROVEMENTS

To Boston from:	Existing Peak Headway	Proposed Peak Headway	Park-n-Ride Locations/Spaces
Hudson/Marlborough via Routes 85, 30 (Express I-90 Exit 12 to Boston)	1 trip	30 mins.	Hudson - 29 spaces Marlborough - 114 spaces Southborough - 70 spaces
Worcester Semi-Express via Rt. 9 (Express from I-90 Exit 12)	2 trips	30 mins.	Shrewsbury - 50 spaces Westborough - 74 spaces
Worcester Express via Rt. 122 (Express from I-90, Exit 11)	30 mins.	30 mins.	Worcester or E. Millbury 75 spaces
Milford	30-50 mins.	no service	None

Required Right of Way Improvements

Worcester Line - The existing roadbed and mainline track is in generally good condition and most of the bridge structures have been recently raised to improve vertical clearances to accommodate double stack freight containers. Additional selective repairs on bridges and culverts are required as is the restoration of a second track with new 132# welded rail, wood ties and fasteners from CP 33 (Westborough) to MP 40.3 (Worcester). The addition of signals, turnout and interlocking improvements would convert an existing uncontrolled siding to a passing siding. A modern fully electronic CTC signal system was recently installed from Westborough to Worcester using cab signals. It is more than adequate for purposes of commuter rail service. A layover facility accommodating four train sets in Worcester is also required, with attendant signal, turnout and interlocking improvements. A single grade crossing in North Grafton must be upgraded to incorporate gates.

Milford Line - This branch is currently in service only from Framingham to Chicken Brook at milepost 7.0 in Holliston. Beyond this point track exists for an additional 2.8 miles, but is not in service. No track exists beyond this. Approximately 27% of the existing ties should be replaced. Since the field survey was performed, it appears that a Conrail tie renewal program is being implemented. The entire 12.3 miles should be laid with new 132# welded rail. Extensive grading and filling would be required in the area of the I-495 underpasses where track no longer exists. An eight span granite stone arch structure over Jar Brook in Holliston requires wing wall repair, and the Highland St. Bridge over the railroad in Holliston requires wing wall repair with tiebacks or replacement. Finally, two cast-in-place box culverts require replacement, including the four, twenty to thirty foot long wingwalls of one of them. Although there is no present structure, the intersection of Route 109 and the railroad would require substantial structural work if the commuter line were to extend to this point. There was a grade crossing at this location, but subsequent to the abandonment of the railroad, Route 109 was raised 8-10 feet to improve highway sight distance and design speed. This crossing would require a highway structure over a depressed railroad with wingwalls, retaining walls and drainage improvements. There are 14 grade crossings which require automatic grade crossing protection improvements, with ten requiring auto flashers and gates and four requiring only the addition of gates. There are also 4 private grade crossings which require the addition of crossbucks and a stop sign. This line is currently not signalled and therefore, the entire cost of track circuits, a control machine, powered turnouts and electric locks is required. A two mile long power operated, remote controlled passing siding and a layover facility to accommodate four train sets are also required.

Marlborough Line - The existing roadbed is in generally good condition and field observations evidence ongoing work to selectively replace ties and improve vertical clearances, perhaps for double stack containers. Approximately 33% of existing ties should be replaced and the entire 10.3 miles laid with new 132# welded rail. The bridge carrying the Route 30/Route 9 connector over the line requires substantial bearing and concrete repairs. Two culverts in Southborough near Cross St. require headwall repair. Protection of five grade crossings must be upgraded, with three requiring only the addition of gates, one requiring auto flashers and gates and one needing crossbucks and a stop sign (private crossing). The line is currently not signalled and therefore, the entire cost of track circuits, a control machine, powered turnouts, and electric locks is required. For operational flexibility, a two mile long power operated remote controlled passing siding and a layover facility to accommodate four train sets is also required.

Stations and Park-n-Ride Lots

The standard MBTA configuration for low level (730' long) and high level access platforms, station canopies and parking lot surfacing, lighting, landscaping, etc. has been assumed for all stations. All parking is on grade, except where demand exceeds the capacity of available land in desired locations. Sites without the capacity to handle a minimum of 250 cars were not considered given the excess of demand over supply at existing stations. Other criteria used to screen the 25 sites considered were site grading, proximity to wetlands and residential land uses, access to major arterials, number of parcels required and inter-station spacing, along with development cost and relocation requirements.

Worcester Line

Ashland Station Options - Four sites were considered in Ashland: Ashland Center, Cherry St., Howe St. and Route 85. The preferred site is at Howe St., which can accommodate nearly 700 on-grade parking spaces and offers good access to Routes 135 and 85, via Cordaville Road. The Ashland Center site (former station) and Cherry St. sites were marginal relative to accommodating commuter traffic and offered very limited expansion possibilities. Cherry St. is near a Superfund hazardous waste site and would likely impact a nearby playground and residential community. The Route 85 site was well located for access but its size limits future expansion possibilities. It would greatly increase turning movements and exacerbate congestion at the existing Route 85/Southville Road intersection. It is too far west for optimal spacing between Framingham and I-495.

Westborough Station Options - After much field investigation, the only promising site identified near I-495 was at Fruit Street off Flanders/Southborough Rd. This site can accommodate up to 1,000 cars on grade and could serve as a major intercept lot for I-495/Mass. Turnpike traffic. Conceptual plans for direct ramps from the I-495/I-90 interchange are provided in Chapter 4. Other sites were either laced with or surrounded by wetlands and/or required extremely circuitous access from the Interstate highway network.

Grafton Station Options - Three sites were considered in Grafton, at Pine St., Parmenter Crossing (Institute Rd.) and Milepost 38.75 (just east of Rt. 140). The extensive grade differential and likely traffic impact on the neighboring residential community mitigate against the Parmenter site. The MP 38.75 site did not yield sufficient parking, would generate traffic impacts in a residential neighborhood and was poorly shaped in relation to the platform layout. The Pine St. site is accessible to Routes 122, 140 and I-90, is located off Route 30, 1.5 miles east of Rt. 140. It is suitable for 250 parking spaces, and offers ready access from Pine St. Shuttle service could easily bring passengers to/from the nearby Tufts School of Veterinary Medicine.

Worcester Station Options - Owing to its importance as a major origin and destination for commuter and non-work trips, four sites were examined in downtown Worcester and an additional three sites as far south as the proposed Route 146/Mass. Turnpike interchange in Millbury. The Worcester Center stations are at the existing Amtrak station, the Salem Municipal Lot, the Wyman Gordon site and the Trailways Bus Station site. The Amtrak site was preferred owing to its current uses, potential for substantial parking expansion beyond the 500 spaces needed, a direct ramp from I-290 and limited impact of traffic on neighboring residential uses. While the ramp modifications and decked parking are expensive relative to sites in less developed areas, the cost per space was substantially less than the Salem Lot and Trailways sites due to low acquisition, relocation and demolition costs. The Wyman Gordon site is relatively isolated, not very visible and the grade differential poses pedestrian and special needs access problems with attendant costs.

South of Worcester Options - Three sites well south of downtown Worcester were examined for potential to serve Mass. Turnpike commuters. The Rt. 146/Mass Turnpike location is preferred due to its convenience to the Turnpike and Routes 20, 122A and 146, the absence of conflicting uses or residential areas susceptible to traffic impacts, capacity for nearly 700 cars and the opportunity to enfold its development into the new Turnpike interchange planning. The Millbury St. South and North sites require restoration of P&W spur trackage through a scrap metals reduction yard and a major development site targeted by the City of Worcester.

Milford Line

East Holliston Station Options - Two sites were considered in East Holliston: Parker Snacks and Lowland St. The preferred site is the Lowland St. site, which offers 500 on-grade parking spaces with expansion capacity. The site provides good access to Rte. 16

via Route 126. The Parker Snacks site offered large enough capacity to accommodate a new commuter station, but expansion capacities were limited. In addition, the site is in very close proximity to an existing aquifer and wetlands, which could create significant adverse environmental impacts.

Holliston Station Options - Two sites were considered in central Holliston: Holliston Center and Hopping Brook. Hopping Brook was considered the preferred site until an environmental investigation was undertaken. The site is easily accessed from Route 16 and is located near the entrance to Hopping Brook Industrial Park with compatible land use. However, the abundance of wetlands in this area, both on and off the site, limit expansion capabilities and present significant environmental problems. The Holliston Center site was originally used as a rail station stop. Its downtown location severely limits at-grade parking capacity and any expansion must be accommodated through additional site acquisition and demolition or by decked parking structures. The additional commuter traffic in Downtown Holliston could also be problematic as the full length of platform intersects two streets.

Milford Station Options - Two sites were also considered in Milford, both near the transportation triangle formed by Routes 109 and 16, together with I-495. Adverse wetland impacts with respect to parking and platform locations, as well as the significant costs anticipated for earthwork and structures at Route 109 if the line is restored all the way to the Sears site mitigate against the selection of this site. The Webber Lumber site, on the other hand, being easily accessed by the aforementioned transportation triangle is adequate in size and siting and compatible with existing land use.

Marlborough Line

North Framingham Station Options - After consideration of several siting options located near Route 9, the Salem End Rd. site emerged as the preferred location owing to its proximity to Rt. 9, the size to accommodate 750 spaces (on structure over the existing Framingham State College lot), and the potential to serve the campus nearby. It will also reduce travel to the existing Framingham station at Union St., relieving several very congested intersections.

West Framingham Station Options - Investigation in the vicinity of California Ave. near the Framingham Industrial Park identified a preferred site north of Rt. 9, accessible to Routes 9 and 30 and about one mile west of a Mass. Turnpike interchange. Acquisition of several buildings would be required, but a 500 space lot on-grade could be accommodated in an area of high demand and also contribute modestly to relief of the existing Framingham station.

Southborough Center Station Options - Several sites near the intersection of Routes 30 and 85 were examined and the preferred site identified just south of Rt. 30 between Park St. and the Fitchburg secondary line, near the site of a former station. A 250 space lot on-grade will require modification of the Park St. alignment and displacement of agricultural uses but, properly shielded and landscaped, should have limited impact on nearby residential uses.

Southborough/I-495 Station Options - After review of several sites east and west of I-495, a preferred site off Northborough Rd. just west of I-495 was identified. A major office/commercial development is planned in this area which will be easily accessed via a proposed interchange near Route 30. Up to 1,000 cars could be accommodated on-grade, with some modifications to the Northborough Rd. alignment.

Year 2010 Patronage Estimates

Commuter rail patronage estimates were generated for the average weekday in the year 2010, based upon anticipated work trips to the Boston CBD area, estimated travel times and train frequencies and projected fares for commuter rail and/or bus services relative to comparable auto operating costs and travel times. Table 3 provides a summary of the daily boardings by station for each of the four rail alternatives as well as the bus boardings for the bus and rail alternatives.

The combination of Marlborough and Milford service in Alternative 3 generates the highest patronage, but the differences between Alternatives 1 and 2 as well as 3 and 4 indicate that the Milford line would add only 550-650 daily boardings at a substantial increase in capital investment requirements. The table also demonstrates the potentially large bus ridership in the Worcester-Boston corridor in Alternatives 3 and 4. Bus ridership in Alternatives 1 and 2 from the Marlborough/Southborough/Sudbury areas is quite low.

TABLE 3
DAILY INBOUND PERSON TRIPS (BOARDINGS)
YEAR 2010*

Lines	Bus Alt.	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Worcester	-	2550	2280	-	-
Milford	-	-	740	790	-
Marlborough	-	-	-	2120	2280
Rail Subtotal	0	2550	3020	2910	2280
Bus Subtotal	1530	40	40	950	950
TOTAL*	1530	2590	3060	3860	3230

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*Excludes Framingham Station

Capital Investment Requirements

Capital investment requirements are bracketed in the range of $76.7 to $85.6 Million for Alternatives 1 and 4 and rise to a higher range of $105.9 to $107.3 Million for Alternatives 2 and 3 owing to the substantial right of way restoration required for the Milford Line from

MP 7 in Holliston to MP 12.3 in Milford. The previously identified right of way improvements, including track, signals and right of way structures, passing sidings and layover facilities, together with the preferred station/park-n-ride lots plus the rolling stock required by the proposed operating plan compose the capital investment requirements. Table 4 below provides these figures.

TABLE 4
CAPITAL INVESTMENT REQUIREMENTS
(MILLIONS OF $1989)

Category	Bus Alt.	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Right of Way Improvements	---	10.9	26.0	27.8	13.0
Stations	---	20.2	23.9	21.3	18.9
Rolling Stock*	---	34.7	38.7	39.8	41.4
Engineering & Contingency	---	10.9	17.3	17.3	11.2
Subtotal - Rail	---	76.7	105.9	106.2	84.5
Subtotal - Bus (inc. eng. & cont.)	5.7	---	---	1.1	1.1
Total	5.7	76.7	105.9	107.3	85.6

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*Rolling stock costs identified here are for the net additional locomotives and coaches required to operate the new rail services under consideration. They do not include the costs required to replace the 22 single level coaches and four locomotives used to offer the current Framingham-Boston local commuter rail service. Chapter 6 (especially Table 6-9) provides further detail on the derivation of rolling stock requirements.

Operation And Maintenance Costs

The net O&M costs of the four alternative rail operating plans range from $4.3 Million for Alternative 4 to $7.1 Million for Alternative 2 with Alternatives 3 and 1 at $6.3 Million and $5.1 Million respectively. Table 5 provides a summary of this data, as well as the net train mile and car mile data.

Perhaps more revealing are the costs per passenger, per car mile and passengers per car mile. Alternative 1 at $7.75 offers a lower cost per car mile than Alternative 4 at $8.66, yet the cost per passenger at $4.33 is appreciably higher than the $3.50 for Alternative 4. The reason for this is the significantly higher (38.5%) demand density for the Marlborough line at 2.47 passengers per car mile versus 1.78 for Worcester. The higher demand density of 2.83 passengers per car mile in Alternative 3 relative to the comparable figure of 1.96 for Alternative 2 reflects the fact that the Worcester and Milford lines tend to serve many of the same travel markets (i.e. significant overlap exists) whereas the markets served by the Marlborough and Milford lines are mostly exclusive to one line or the other. Thus, the net cost per passenger for Alternative 3 at $4.46 is 10% lower than the $4.98 for Alternative 2, despite a nearly 30% higher ($12.61 vs. $9.76) cost per car mile.

TABLE 5
RAIL O&M COSTS*

	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Train Miles	222,182	260,212	192,937	120,875
Car Miles	655,396	724,039	498,648	500,226
Passengers (M)	1.17	1.42	1.41	1.24
Annual O&M Cost ($ M)	5.08	7.07	6.29	4.33
Cost/Pass.	4.33	4.98	4.46	3.50
Cost/Car Mile	7.75	9.76	12.61	8.66
Psgrs/Car Mile	1.78	1.96	2.83	2.47

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*All figures presented in this table reflect the additional rail service offered above and beyond Framingham-local service, i.e. they are net figures.

Fare Revenues

The predicted demand density is relatively high. Coupled with the fact that forecast patrons are for a 2010 horizon year while O&M costs are expressed in 1989 $, the fare recovery ratios are more positive than would likely occur. They are, however useful in comparing amongst the alternatives. Table 6 provides the O&M cost, fare revenue and revenue to cost ratio for each alternative. Of note here is the effect of the higher average fare for the Worcester Line (due to higher zone charges in the MBTA's distance based zone fare system) in causing significantly better revenue/cost ratios for Alternatives 1 and 2.

Cost-Effectiveness Results

Taken as a whole, the ridership and costs estimated for the several alternatives provide some interesting comparisons. The total capital investment, annualized capital costs (using OMB's 10% discount rate), O&M costs, ridership and revenues can be combined to form various measures of cost-effectiveness as shown in Table 7. The figures clearly show that coupling the Milford Line with either the Worcester or Marlborough line (as in Alternatives 2 and 3) yields less favorable cost effectiveness results than Worcester alone (Alt. 1) or Marlborough alone (Alt. 2).

TABLE 6
RAIL REVENUE AND OPERATING RATIO RESULTS*

	Alt. 1	Alt. 2	Alt. 3	Alt. 4
O&M Cost ($ M)	5.1	7.1	6.3	4.3
Fare Revenue ($ M)	3.8	4.9	2.6	1.7
Rev./Cost Ratio	0.75	0.69	0.41	0.40

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*All figures presented in this table reflect the additional rail service offered above and beyond Framingham-local service, i.e. they are net figures.

TABLE 7
RAIL COST EFFECTIVENESS RESULTS*

	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Annualized Capital Cost ($ M)	8.3	11.5	11.6	9.1
Annual O&M Cost ($ M)	5.1	7.1	6.3	4.3
Total Annualized Cost ($ M)	13.4	18.6	17.9	13.4
Net Annualized Cost Less Revenues Cost ($ M)	9.6	13.7	15.3	11.7
Annual Riders (M)	1.17	1.42	1.41	1.24
Total Cost/Rider	11.45	13.10	12.70	10.81
Net Cost/Rider	8.21	9.65	10.85	9.44

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*All figures presented in this table reflect the additional rail service offered above and beyond Framingham-local service, i.e. they are net figures.

Operational and Scheduling Issues

Using a stringline chart containing the proposed MBTA trains, AMTRAK trains and CONRAIL's freight trains a capacity analysis of the rail line between Worcester and Boston was made: Train performance simulations were also used to pinpoint the ideal locations for the passing sidings on the Milford and Marlborough lines. The conclusions of these analyses are as follows:

- The few added trains between Framingham and South Station would not cause any capacity constraints in this segment of line nor change any freight windows provided that midday storage of trains is not required at Milford, Marlborough or Worcester. If midday storage is required at the outer points, freight windows would be changed, and it is recommended that full reserve running capability be installed between Boston and Framingham by completing the link between CP11 and Framingham on Track 1 to compensate for the reduced capacity.

- Between Worcester and Framingham, rather than construct a passing siding at North Grafton as originally planned, the siding (or maintrack) should instead be placed between MP 40.3 and Worcester if only peak hour trains are operated to Worcester. If off-peak service is operated as well, double track with reverse running should be restored between CP 33 and Worcester because 44 trains per day would be operating on this link.

- Taking the added Framingham trains in isolation without considering growth on other lines (except the Old Colony), there would be capacity in South Station to handle the added Framingham line trains. If there is growth on other lines also, whether capacity exists for them depends upon the proposed schedules.

- The ideal location for the sidings on the Milford and the Marlborough lines would place the east end of the sidings 12 minutes from Framingham on both lines and the west end of the sidings 8 minutes from Milford and Marlborough. On the Milford line, this would ideally place the siding between MP6 and 8. On the Marlborough line, the siding would be ideally located between a point 2.5 miles west from the junction at Framingham Center to Oak Hill Road. The California Avenue station may or may not be in these siding limits depending upon the final station location. If the sidings can not be placed in the ideal location, the achievable headways will be increased 2 minutes for each minute the siding is located from the ideal location.

Environmental Issues

Restoration of commuter rail service to Worcester, Milford or Marlborough must comply with the requirements of the Massachusetts Environmental Policy Act (MEPA), as well as a number of other State regulations and laws. In addition, if federal funds are sought, the requirements of the National Environmental Policy Act (NEPA) also must be addressed. Because the rail lines pass through vital wetlands resources such as the Great Cedar Swamp and border on aquifers or surface drinking water resources, restoration of commuter rail service on any line would be considered to be a "categorically included" project under MEPA, and therefore would require preparation of at least an Environmental Notification Form (ENF).

After circulation of the ENF for public comment, a decision would be made by the Massachusetts Executive Office of Environmental Affairs on the need for further impact documentation and mitigation of adverse impacts in the form of an Environmental Impact Report (EIR). The need for, and scope of, an EIR is likely to be primarily a function of the impacts expected at each of the candidate station sites. These, in turn, will relate to land acquisition required, the number of parking spaces to be provided, and the associated traffic effects, as well as the potential for impacts on wetlands, flooding, and wildlife habitat.

Many of the preferred station sites are located in areas that are zoned for commercial and industrial uses and, as such, should present no problem with respect to land use or zoning. Certain other sites are currently zoned for residential uses. Special attention, therefore, needs to be paid to the border conditions and to parking lot design and access.

Operation of commuter rail service will produce noise and vibration along the right of way as trains pass. In the built-up areas where buildings are located near the track, this could be of some concern. These impacts can usually be minimized through proper reconstruction of the trackbed. These noise levels are not expected to create serious impacts as preliminary analyses indicate increases in L_{eq} to be under the UMTA threshold of significance.

The existing trackbed passes through an area of significant sensitivity with respect to the natural environment. Adjacent wetlands are of great natural beauty, with surprisingly little development given the proximity of the corridor to the Boston metropolitan area. The quality of water bodies traversed by the railroad embankment, however, would not be affected in the long term by reconstruction of the railbed, assuming no widening of the embankment. Provisions to protect water quality during construction should be included in construction specifications.

Next Steps in the Planning Process

This Final Report provides information necessary to consider the extension of commuter rail service to Worcester, Milford and Marlborough. It reflects comments received during presentations to local officials, planners and interested citizens. The report concludes that service to Milford via Framingham does not merit further consideration. The report provides a basis for making decisions on funding for project engineering and construction. If the decision is made to proceed toward service restoration, the next steps will involve carrying out preliminary engineering (Alternatives Analysis if Federal funds are sought) and beginning the environmental assessment process by submitting an Environmental Notification Form to the Massachusetts Executive Office of Environmental Affairs.

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CHAPTER 1

INTRODUCTION

Continued economic growth in metropolitan Boston and attendant traffic congestion contribute to an increasingly favorable climate for attracting commuters out of their automobiles and onto transit. Substantial improvements in the amount of service supplied, the quality of that service (closer headways, more comfortable/reliable equipment, network extensions), and attractive pricing have made commuter rail one of the MBTA's outstanding success stories. Ridership on the commuter rail network has grown by more than 60 percent in 10 years, and with the completion of Southwest Corridor and Needham restoration projects, attention is shifting to other network expansion possibilities.

The extraordinary growth in commercial and office space, employment and residential development has severely strained the existing transportation network. Continued growth in the high technology and medical sectors, the need for less costly housing, and associated demands for improved white collar/support worker mobility have created a growing need to connect the Metro West region and Boston.

In a manner comparable to efforts already completed for the Newburyport and Old Colony restoration projects, the MBTA, by request of the state legislature, commissioned a study to establish the basic feasibility and an estimated cost of restoring service on the former Boston and Albany (now Conrail) right-of-way from the existing terminal in Framingham to downtown Worcester, a service that was terminated in 1975. Two major branches which join the B & A main line at Framingham and serve additional markets somewhat removed from the Franklin/Forge Park and Fitchburg lines were also considered. The Holliston Industrial Line (formerly the Pink Granite Line) passes through Framingham, Sherborn and Holliston enroute to Milford just west of I-495. The Framingham Secondary/Fitchburg Secondary line penetrates North Framingham, Southborough and finally Marlborough just west of I-495. The study reported on herein considers the likely market penetration, station siting, design, operations choices, and potential environmental concerns for the two branches as well as the B & A main line.

1.1 THE PROPOSED SERVICE RESTORATION

The commuter rail service restoration proposed is essentially an extension of the current Boston-Framingham service to Worcester, Milford and Marlborough, as depicted in Figure 1-1. Over the distances between these towns, existing rights-of-way, in some cases new, and in other cases aging tracks, ties and ballast still exists. It is these alignments that are proposed for reuse.

Stations similar to those that exist at other MBTA commuter rail stops were examined for location in Ashland, Westborough, Grafton, Worcester, Holliston, Milford, Framingham, Southborough, and Marlborough. The operating strategy is assumed to be an extension of the current MBTA practices and schedules, with some flexibility for modification.
Rail facilities would be brought up to full MBTA standards relative to station design and

access, track, signalization, bridges, protection at grade crossings, and fencing along the right-of-way.

1.2 THE CURRENT STUDY

Restoration of Worcester, Milford or Marlborough service is however, more complex than merely running Framingham trains up the existing tracks. Public safety must be assured, and negative effects on current Framingham line and other South Station users must be avoided. The tasks of this project have been to:

- survey existing track and bridge conditions and identify necessary improvements;
- recommend station sites and parking requirements;
- investigate the need for ancillary facilities such as passing track and overnight layover locations;
- prepare capital cost estimates;
- develop patronage estimates for the year 2010, to include the impacts of population and employment projections;
- identify operational and scheduling issues;
- assess the expected significance of environmental impacts; and
- examine the economics of the proposed service based on estimated costs, revenues, and system benefits.

Contacts have been made with elected officials and town planners along the corridor from Framingham to Worcester, Milford and Marlborough to solicit further information and local perspectives, and with the Massachusetts Historical Commission and the Massachusetts Natural Heritage Program. A thorough inspection of the railway has been made, and extensive photographic material has been developed.

Some local communities have expressed strong support for the proposed service extension, while others are less enthusiastic. Although selective track, tie, and ballast replacements; upgrading of grade crossing protection; new station locations; rehabilitation of the railroad bridges and culverts; and reconstruction of the several bridges appear necessary, there are no other major physical barriers to restoration of service except in Milford where some encroachment was observed on the abandoned right-of-way.

Alternative station sites and concepts have been defined in all communities directly traversed by the three lines considered. Ridership estimates indicate that the new stations are likely to be used each weekday in the year 2010 by 2550 commuters on the

Worcester Line only, 3020 for the Milford/Worcester combination, 2280 for the Marlborough Line only and 2910 for the Marlborough/Milford combination. The environmental assessment work suggests that, with appropriate mitigation measures, the required construction activities and subsequent service operation will not have unduly adverse environmental consequences. Capital expenditures, excluding rolling stock costs, to restore Worcester service are estimated to be $42.0 Million (1989 dollars). A comparable figure for Milford is $25.3 Million and for Marlborough is $43.1 Million. Annual operating costs in the year 2010 are expected to be on the order of $5.1 Million for Worcester, $2.0 Million for Milford and $4.3 Million for Marlborough, to be at least partially offset by approximate increased annual revenues of $3.8 Million, $1.0 Million and $1.7 Million respectively. Each of these estimates assume a continuation of present service levels for all stations on the Framingham line, and dollar figures are based on 1989 dollars.

There are, however, several aspects of facility and service design where policy decisions remain to be made. The location and length of passing sidings along the right-of-way remain subject to further detailed study of train speeds, scheduling and detailed coordination with Conrail. Likewise, means of providing and funding bus feeder service to selected stations, using either private or public bus operations, should be investigated. Finally, the issue of providing service on weekends and holidays remains to be resolved. In each of these cases, information is provided in this report to assist decision-makers in evaluating the available options.

1.3 PURPOSE AND STRUCTURE OF THIS REPORT

This report summarizes the technical work performed. Chapter 2 presents background information on the communities to be served and existing transport services. A summary of existing conditions and infrastructure improvement requirements is given in Chapter 3. Station requirements and concepts are described in Chapter 4. Chapter 5 describes the preliminary ridership forecasts and Chapter 6 presents operational issues. Chapter 7 identifies potential environmental issues and documentation and permitting requirements. The final chapter summarizes projects costs and identifies transportation and economic impacts.

This document is intended to serve as the basis for review and comment in order to reach a decision regarding whether the restoration of commuter rail service to Worcester, Milford, and Marlborough merits further consideration and/or action to move the project(s) forward to implementation.

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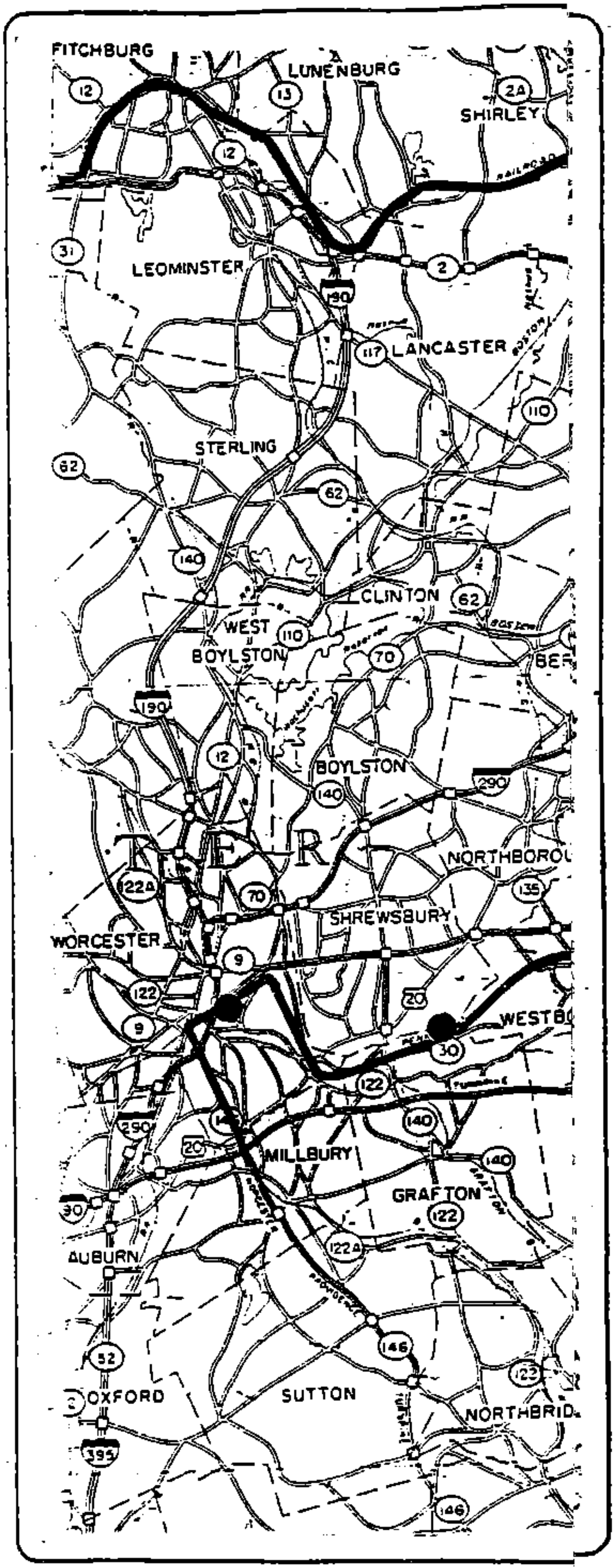
TRANSPORTATION
AUTHORITY

WORCESTER/MILFORD/MARLBOROUGH COMMUTER RAIL EXTENSION FEASIBILITY STUDY



━ EXISTING COMMUTER RAIL SERVICE FITCHBURG, FRAMINGHAM, FRANKLIN

━ PROPOSED FRAMINGHAM TO MARLBOROUGH EXTENSION

━ PROPOSED FRAMINGHAM TO MILFORD EXTENSION

━ PROPOSED FRAMINGHAM TO WORCESTER EXTENSION

ON-LINE TOWNS

● POTENTIAL STATION LOCATIONS

GENERAL LOCATION PLAN and ROUTES

Figure 1

CHAPTER 2

SERVICE AREA AND PROPOSED ALTERNATIVES

This chapter describes the communities that would be served by the proposed commuter rail extensions, existing transit services that are available and each alternative for rail and bus service.

2.1 COMMUNITIES TO BE SERVED

Each of the rail extensions considered in this feasibility study would directly serve a specific group of communities that form primary catchment corridors The corridors are not entirely mutually exclusive. Through the use of park and ride facilities at major highway intersections, the Marlborough and Worcester options can serve many of the same communities. The Milford extension would serve a different group of towns but would compete at its outer end with the Franklin Line. The communities within the corridor for each proposed rail extension can be divided into two groups; those communities directly served by the rail line and those communities that are outside of the rail corridor that would also benefit from the rail extension. The latter tend to overlap. Both groups need to be considered in the study.

Worcester Corridor

Two of the alternatives in this study serve Worcester as a terminus. As the center of a Metropolitan Statistical Area, Worcester functions as a center of employment, finance, and retail. Consequently, a relatively small percentage of these functions are oriented toward Boston. There is a notable number of work trips that are made from Worcester to Boston, however. These work trips were estimated by CTPS to be 780 for 1987. Due to growth in the Boston region, there is anticipated growth in the Boston-oriented population in Worcester. CTPS has projected an increase in work trips to Boston to 1030 by 2010, while Worcester is forecast to have a 2.4 percent population increase from 166,000 to 170,000 during the same period. Worcester benefits from well developed regional highway connections centered on Interstate 290, which in turn provides access to Interstate 495 and the Massachusetts Turnpike (Interstate 90). These connections, plus the fact that the Turnpike is not highly congested, tend to encourage automobile travel to Boston.

Intermediate stations under the Worcester alternatives are proposed for Grafton, Westborough and Ashland. Grafton is a smaller community that has historically been oriented to Worcester. As a result, the number of work trips to Boston was estimated at only 26 for 1987; CTPS has forecast an increase to 45 for 2010. Westborough has become more oriented toward Boston. This change in orientation has been a result of the development of a highway network providing easy access to the Massachusetts Turnpike via Interstate 495. Work trips to Boston are estimated to be 294 for 1987, with an increase to 371 for 2010 (26%). At the same time, the population of Westborough is forecast to increase from 13,100 in 1987 to 13,600 in 2010 (3.8%). It must be noted that Interstate 495 has generated considerable employment along its path; thus, many work trips are not oriented to either Boston or Worcester. As a result, while employment of Westborough residents in Boston may show an increase, other areas along Interstate 495 may show an equal or greater increase. Ashland is adjacent to Framingham, and has a greater Boston orientation than any of the other communities. The number of Boston work trips for Ashland is estimated to increase from 166 in 1987 to 286 in 2010 (72%). Some Ashland residents currently use the existing Framingham commuter rail line for travel to Boston. A license plate survey of parked cars conducted by the Town of Framingham in 1988, found 36 cars registered to Ashland residents, out of 199 counted.

Milford Corridor

A rail extension to Milford from Framingham would directly serve Holliston, Hopkinton and Milford. Milford is the largest community in this service area. Its population is estimated to change very little in the next two decades; the population projected for 2010 is only 200 persons greater than the 1987 estimate of 24,280. During the same period however, work trips to Boston are forecast to increase to 450 from the 1987 estimate of 320.

In considering the Milford branch from Framingham examined in this feasibility study, it has been assumed that another rail extension to Milford will be undertaken, a continuation of the Franklin/Forge Park line via Bellingham. Proposed Milford station locations differ for each branch. The two station sites are separated by 1 to 1 1/2 miles depending upon the final selection of sites. As a result, each station might attract riders from a differing section of Milford than the other, assuming each branch had comparable travel times.

Holliston and Hopkinton would be served directly by the extension of the Framingham Line to Milford, but not by the extension of the Franklin Line to Milford. Holliston had an estimated population of 12,950 for 1987; an 8 percent increase to 14,000 projected for 2010. Work trips to Boston are assumed to grow 50 percent during the same period from 295 to 441. Hopkinton is also anticipated to have a population increase of about eight percent; its work trips to Boston will increase like those in Holliston by 50 percent from 207 to 308. These three communities comprise the primary service area. Other smaller communities, such as Hopedale and Upton, will likely contribute small numbers of work trips proportional to their population. The only other large population center in this area is Bellingham. It is likely, however, that all of the Boston work trips from Bellingham that are made by commuter rail will be on the Bellingham extension of the Franklin/Forge Park line.

Marlborough Corridor

A rail extension to Marlborough would include Southborough and Marlborough in its primary service area. These two communities, like Westborough, have grown as highway connections to Boston have improved. Marlborough is estimated to grow in population from 31,150 to 35,250 (13%) between 1987 and 2010. Work trips to Boston are forecast to grow from 364 to 568 (56%) during the same period. Southborough is a smaller community than Marlborough; its population is estimated to grow from 6,430 to 7,700

(12%) between 1987 and 2010, with work trips to Boston showing a commensurate increase from 211 to 349 (65%). Other communities that would be in a secondary market for this extension include Westborough, Shrewsbury, Northborough, and Berlin.

2.2 EXISTING TRANSPORTATION SERVICES

A number of private bus companies operate service from the communities in the study area to Boston. The majority of service is provided by Peter Pan Bus Lines. Peter Pan serves Worcester, Shrewsbury, Westborough, and Southborough. Several smaller carriers serve the communities in the Milford and Marlborough rail corridors. Also drawing riders from parts of the study area is park and ride bus service provided from Shoppers World in Framingham to Boston via the Massachusetts Turnpike. While the various bus services in the study area may be significantly impacted by the rail alternatives, the Shoppers World service will be assumed to remain in place for all alternatives. Table 2-1 summarizes current bus operations in each service area.

Worcester/Boston Service

Peter Pan provides non-stop service along the Massachusetts Turnpike (I-90) from its terminal in downtown Worcester to its Boston terminal near South Station at approximately hourly headways throughout the day. Half hourly service is provided at peak periods. Peak period trips discharge inbound passengers at Copley Square (Back Bay) and Park Square. Scheduled trip time from Worcester to South Station is 60 minutes. This service also carries approximately 300 inbound riders per day, with fewer passengers travelling on weekends. Limited additional service operates along Route 9. Two morning trips operate "semi-express" on weekdays from Worcester to Boston via Framingham. These trips serve Route 9 points including Shrewsbury, Northborough, Westborough, and Southborough until reaching Framingham. After Framingham, these trips operate over the Turnpike to Boston. These "semi-express" trips carry approximately 50 weekday inbound passengers. Finally, local service is offered at intervals between 90 and 120 minutes along Route 9 between Worcester, Framingham, and Boston. As the local service is operated on an infrequent basis, it does not generate much usage for work trips. About 60 daily inbound passengers use the local route. Peter Pan has applied to the MBTA for a subsidy for the Route 9 service, and would increase service if the subsidy is approved. Its other services in the corridor are not subsidized. The fare from Worcester to Boston is currently $6.00 each way.

Milford Service

Two private carriers provide service from Milford to Boston. Brush Hill Transportation operates three peak trips to Boston in the morning, with three return trips in the evening. This service operates over Routes 109, 128, and I-90. Between 65 and 75 inbound riders are carried on this service. Intermediate communities served include Medway, Millis, Medfield, and Westwood. Trips from Milford to Boston are scheduled for 77 minutes, with Boston stops at Greyhound and South Station. The fare for a one-way trip is $3.60. The other carrier serving Milford is Big W Transportation, which operates to Framingham. This service operates through Ashland, Holliston, and Hopkinton. Service is operated Monday through Saturday at infrequent intervals.

Marlborough/Boston Service

Two private carriers provide minimal service between Marlborough and Boston. Big W Transportation operates one morning inbound and one afternoon outbound trip along the Boston Post Road (Route 20) serving Marlborough, Wayland, Sudbury, and Weston. Travel time between Marlborough and Boston is approximately 60 minutes. About 16 inbound riders use this service. The other carrier serving Marlborough is Gulbankian Bus Lines. That company provides service three times each weekday between Hudson, Marlborough, Southborough and Boston along Routes 85, 9, and I-90, with one round trip during each peak period and one midday trip. Scheduled running time is 60 minutes from Marlborough and 50 minutes from Southborough to Boston. Approximately 20 inbound riders use the Gulbankian service each weekday. The Big W Transportation service to Marlborough receives a subsidy from the MBTA. The Gulbankian service is not subsidized. Fares for these services are $3.50 - $3.60 each way.

Table 2-1 below summarizes the key fare and service characteristics of the private carrier express bus services.

TABLE 2-1

CURRENT BUS OPERATIONS IN RAIL EXTENSION STUDY AREAS

Boston to: (One Way)	**Fare**	**Peak Headway**	**Running Time**
Worcester (Express)	$6.00	30 min	60 min
Worcester	$6.00	2 trips	90 min
Shrewsbury	$4.05		80 min
Westborough (Semi-Express via Route 9)	$4.05		70 min
Hudson	$4.00	1 trip	75 min
Marlborough	$3.50		60 min
Southborough (via Routes 85 & I-90)	$3.00		50 min
Marlborough via Post Road (Route 20)	$3.60	1 trip	65 min
Milford	$3.60	30 min	77 min

2.3 IMPLICATIONS ON RAIL ALTERNATIVES

A comparison can be made between proposed rail operating times and current bus operating times based on published timetables. These times are summarized in Table 2-2. For service to Worcester, the rail line would not be competitive with express bus service due to the time required for local stops between Back Bay Station and Framingham. It would be necessary to operate Worcester trains express between Back Bay and Framingham in order to achieve a competitive operating time. Similarly, rail travel times to Marlborough are only superior to both bus routes if express service to Framingham is included. For Milford service, the rail line provides a faster trip than the bus, but only minimally faster if operated with local stops from Back Bay to Framingham. This assessment of potential rail competitiveness with existing bus travel times was considered in the development of the rail service alternatives presented in the following section.

TABLE 2-2

EXISTING BUS AND PROPOSED RAIL TRAVEL TIMES

South Station Boston to:	Existing Bus	Rail - Express Boston to Framingham [1]	Rail - Local Boston to Framingham [2]
Worcester	60 minutes	67 minutes	82 minutes
Marlborough	60-65 minutes [3]	58 minutes	73 minutes
Milford	77 minutes	60 minutes	75 minutes

[1] These times were derived using Amtrak timetables for service between South Station and Framingham, to reflect express operation between Boston and Framingham.

[2] These times reflect a rail service extension of the existing Framingham service, including all current Framingham line stops.

[3] Marlborough bus travel times are for the Gulbankian and Big W Routes, respectively.

2.4 DESCRIPTION OF ALTERNATIVES

Four rail alternatives and one bus alternative were developed for analysis under this feasibility study. The rail alternatives include combinations of three possible extensions of service beyond Framingham to Worcester, Marlborough, and Milford. The alternatives are:

Rail Alternative 1 - Worcester Only
Rail Alternative 2 - Worcester and Milford
Rail Alternative 3 - Marlborough and Milford
Rail Alternative 4 - Marlborough Only

Bus Alternative - Marlborough and Worcester

The Marlborough and Worcester rail options both draw from many of the same surrounding towns for their ridership base. As a result, there are no alternatives which combine Worcester and Marlborough together as rail services. Each of the alternatives is discussed in greater detail below. A summary of the headways for all rail alternatives is provided in Table 2-3.

Rail Alternative 1 - Worcester Only

Alternative 1 extends MBTA commuter rail service to the west from the present Framingham terminus. The additional distance from Framingham to Worcester is approximately 23 miles. Station locations are proposed for Ashland, Westborough, Grafton, and downtown Worcester. Under this alternative, the Ashland station would be likely to attract riders from Ashland, Holliston, Hopkinton, and Southborough. The Westborough station is proposed to be near the junction of Interstate 495 and the Massachusetts Turnpike. Westborough would be a major park and ride facility to serve riders from communities along I-495 such as Westborough, Marlborough, Berlin, and Milford, and from adjacent communities such as Northborough and Shrewsbury. The Grafton station, sited near the Tufts University School of Veterinary Medicine, would attract riders from Grafton, Millbury and communities to the south. The downtown Worcester terminus for the commuter rail service would be located at the Amtrak station. In response to the planned upgrading of Route 146 and contemplation of a future Turnpike interchange with Routes 146 and 20, additional station locations were examined south of the Worcester CBD near Millbury Street and in proximity to the proposed interchange in the town of Millbury. These afford reasonable options for further extension in the future. Chapter 4 provides further discussion of station sites.

It is proposed to operate the Worcester extension with half-hourly headways during peak hours. Off peak service would be provided at approximately two-hour intervals, reflecting MBTA commuter rail service practice elsewhere.

TABLE 2-3
HEADWAYS UNDER EACH RAIL ALTERNATIVE

Peak Period Headway (in minutes) and Service Type

ALT 1: Worcester Only
ALT 2: Worcester & Milford
ALT 3: Marlborough & Milford
ALT 4: Marlborough Only

E= Express from Framingham to Back Bay Station;
L= Local from Framingham to Back Bay Station)

Stations:	ALT 1	ALT 2	ALT 3	ALT 4
Worcester	30E	30E	---	---
Grafton	30E	30E	---	---
Westborough	30E	30E	---	---
Ashland	30E	30E	---	---
Milford	---	30L	30E/L*	---
Holliston	---	30L	30E/L*	---
E. Holliston	---	30L	30E/L*	---
Southborough/495 (Marlborough Branch)	---	---	30E/L*	30E
West Framingham (Salem End/ California Ave)	---	---	30E/L*	30E
Downtown Framingham (Current Station)	30E 30L	30E 30L	30E 30L	30E 30L

* Trains at these stations would alternate between express and local.

Peak period Worcester trains are proposed to operate express from Framingham to Back Bay Station. This option would result in a rail travel time of approximately 67 minutes from Worcester to South Station. Existing Framingham trains would continue to operate, making all local stops to Boston. These two trains would be coordinated so that express trains would leave first, and thus not be obstructed by a local train.

Under Alternative 1, it has been assumed that the Worcester to Boston express bus service would not be expanded. It must be acknowledged, however, that bus service in that corridor may continue to operate, since it does not receive financial assistance from the MBTA. Furthermore, many of the trips between Worcester and Boston originate in Springfield. Service from Springfield would not be affected by the initiation of rail service between Worcester and Boston; thus the buses might still stop in Worcester and operate as a feeder service. Finally, because Peter Pan Bus Lines is a private company, it may attempt to compete with the rail line, given the anticipated growth in the number of trips from Worcester to Boston. The semi-express bus service was initially assumed to continue in its current form. However, all trips in its service area were assigned to the rail service. The limited number of semi-express trips currently operated would suggest that this bus could not compete with rail service. Thus, it was eliminated from this alternative for costing purposes.

Rail Alternative 2: Worcester and Milford

Alternative 2 would provide the same service to Worcester as Alternative 1. However, the local service that currently terminates in Framingham would be extended to Milford, making additional stops in East Holliston and Holliston. Under this alternative, a park and ride lot would be located near the junction of Interstate 495 and Route 109 in Milford. The Milford branch would extend the Framingham line approximately 12.3 miles.

Milford trains are assumed to replace current Framingham trains during peak periods under this alternative. Shuttle service between Milford and Framingham will be offered during off-peak periods. Off peak (midday) service will operate every two hours from Worcester to Back Bay and South Station via Framingham, making all local stops as in Alternative 1. Milford shuttle service will be scheduled to meet Worcester trains in the off peak.

The Milford service presented under this alternative would operate at 30 minute peak frequencies, and is estimated to have a running time of 75 minutes. This travel time compares favorably with the current Milford bus travel time of 77 minutes.

Alternative 2 reflects the same assumptions as Alternative 1 regarding bus service with one exception. The current bus service to Milford would terminate in Medway, due to Milford bus riders being diverted to the rail line. All other bus operations are assumed to be unsubsidized, as noted in Alternative 1.

Rail Alternative 3: Marlborough and Milford

This alternative extends the Framingham commuter rail service along two branches to Milford and to Marlborough/Southborough. Milford service would add 12.3 miles to Framingham trains (one-way) as described in Alternative 2. Branch service to Marlborough/Southborough would add approximately 10.4 miles. The Marlborough/Southborough branch would divert from the Framingham line along the Framingham/Fitchburg secondary lines through Southborough to a junction just past the Marlborough city line. At that point, the proposed line turns back into Southborough and continues to a terminus at Interstate 495. Station locations on the Marlborough/Southborough branch are proposed for Salem-End (North Framingham), California Avenue near Massachusetts Turnpike Exit 12 (West Framingham), near Main Street (Southborough) and near Interstate 495. Park and Ride facilities would be available at all these locations. The Marlborough service is estimated to have a running time of 73 minutes.

Service is proposed to alternate between local and express trips on each branch during peak hours. For example, a Marlborough express and a Milford local will depart their respective termini at approximately the same time. After leaving Framingham, the Marlborough train will operate express to Boston, with the Milford train making all local stops. The next peak departure couplet will consist of a Marlborough local and a Milford express. Table 2-4 summarizes estimated local and express operating times for peak hour trains under this alternative.

TABLE 2-4
ESTIMATED OPERATING TIMES - RAIL ALTERNATIVE 3

Boston to:	**Local**	**Express**
Framingham	50 minutes	35 minutes
Marlborough/Southborough	73 minutes	58 minutes
Milford	75 minutes	60 minutes

During the off-peak hours, local service from Marlborough is proposed to be operated at two hour headways. In the mid-day, shuttle service will be offered from Milford to Framingham, scheduled to meet the Marlborough through service at Framingham.

Bus service under Alternative 3 would be modified from the current operation. Milford buses would extend only to Medway, as in Alternative 2. The route linking Marlborough, Southborough, and Boston would not be expanded, since the MBTA would be subsidizing rail service in the same corridor. Otherwise, all Peter Pan buses operating along Route 9 and the Mass. Pike would be assumed to operate in the current manner.

Rail Alternative 4: Marlborough Only

Alternative 4 extends current local service from Framingham to Marlborough/Southborough only. It would be operated in a similar manner as the service through Marlborough and Southborough in Alternative 3, with regard to station stops and routing. Service under this alternative would be operated at 30 minute peak headways and 120 minute off peak headways. The primary service area for this alternative would include the towns of Southborough, Marlborough and, portions of Framingham not currently served by commuter rail. A secondary service area exists for this alternative that is dependent upon automobile access to the stations. That service area includes communities as far west as Worcester. Also included would be communities along Interstate 495, such as Berlin or Upton.

Service to Marlborough/Southborough will be operated express in the peak period. Under an express operation, all local stops would be made between the terminal at Interstate 495 and Downtown Framingham, with continuing express service to Boston's Back Bay and South Station. The running time would be 58 minutes. In comparison, the existing bus service in this corridor has a running time of 60 minutes from Marlborough and 50 minutes from Southborough; that bus operates express from Turnpike Exit 12 to Boston. It is assumed that this bus service will not continue to operate if MBTA commuter rail service is initiated. All other express bus service would continue to operate.

Bus Alternative

In the absence of a commuter rail extension beyond Framingham, improvements in express bus services from the study area may be necessary to accommodate the growing number of trips destined for downtown Boston. These improvements might be provided by private carriers at their own expense, or might require MBTA subsidy. The bus alternative included in this study was based on modifying existing bus operations. Bus improvements can be divided into three geographic sub areas, much the same as the commuter rail extensions have been defined for examination. The geographic areas for bus alternatives include: Worcester/Shrewsbury/Westborough, Southborough/Marlborough/Hudson, and Milford.

Worcester/Shrewsbury/Westborough

The existing non-stop service to Boston from Worcester provided by Peter Pan Bus Lines operates at frequencies of 30 minutes in the peak and about 60 minutes in the off-peak. While it may be possible to increase peak headways to 15 minutes, the thirty percent growth in the number of Worcester to Boston work trips in 2010 (1030) may not justify that level of service. However one improvement that should be undertaken is the location of a formal park and ride facility between downtown Worcester and the Massachusetts Turnpike interchange in East Millbury. Currently, an unofficial park and ride has developed at Grafton Hill Plaza, where riders must cross Route 122 to board the bus, as the bus does not enter the parking lot.

Improvements should also be instituted in the Peter Pan "semi-express" service between Worcester, Framingham, and Boston. This service is currently limited to two morning trips and one evening trip that operate along Route 9 through Shrewsbury, Westborough, and Southborough. This service should be expanded to provide half-hourly peak service. Off-peak service can be provided by the Peter Pan Worcester to Boston Route 9 local. There are numerous opportunities for park and ride locations along this route that may be used informally at the present. Park and ride service will require 270 park and ride spaces in Shrewsbury and in Westborough, as well as some additional spaces in towns such as Northborough and Southborough (assuming single occupant vehicles). Officially designated park and ride lots, along with providing half-hourly frequencies, would make the bus service much more attractive in this area. Given the anticipated increase in demand, these "semi-express" trips should access the Mass. Pike at Exit 12 in Framingham, rather than travel through Shoppers World as they currently do. Shoppers World is already served by another Peter Pan service.

Marlborough/Hudson/Southborough

Existing bus service to Boston is extremely limited from the Marlborough/Hudson area. Although two distinct routes operate to Boston, service is currently limited to one peak trip on each of the routes. In order to make service more attractive, an increase in service to half-hourly would be justified, given the total number of work trips to Boston from Marlborough and Hudson alone, which is estimated to be 720 in 2010. This increase in service would likely be focused on the Hudson/Marlborough/Southborough route currently operated by Gulbankian Bus Lines, which has the shorter running time of the two services from Marlborough to Boston.

In conjunction with improvements in service frequencies, park and ride lots should be developed to make access to the bus easier. Park and ride lots should be located in all three communities traversed by this bus before it accesses the Mass. Turnpike. This action would expand the service area to include communities that would otherwise not support bus service, such as Berlin and portions of Northborough, in addition to areas of Marlborough and Hudson that are not currently within walking distance of the bus route. For the communities of Hudson, Marlborough, and Southborough, CTPS has forecast 150, 570 and 350 daily work trips in 2010 to Boston, respectively. If a minimum of twenty percent of those trips could be captured by bus, 30, 114, and 70 park and ride parking spaces would be needed for Hudson, Marlborough, and Southborough respectively assuming one space per commuter.

As a further improvement in bus service from Marlborough, frequencies could be improved on the bus route that operates from Marlborough to Boston along the Post Road (Route 20), currently operated by Big W Transportation. However, improvements in the Gulbankian service would attract the majority of Marlborough riders, with the possible exception of the east side of Marlborough, an area of extensive residential and commercial development. As a result, any improvements in the Big W service would mostly benefit riders in towns outside of the commuter rail extension study area, such as Sudbury, Wayland, and Weston. Therefore, for the purposes of this study, improvements in service to Marlborough will be limited to the Gulbankian route.

Milford

Existing bus service to Milford operates at low frequency, and offers a time consuming routing for passengers travelling the entire distance from Milford. The institution of express service from Milford to Boston along Route I-495 and the Mass. Pike would minimize travel time, and make the bus a more attractive travel option. Currently, park and ride locations do exist and could be used for express service as well. Since it is assumed that commuter rail service will be available from Milford to Boston via Franklin even in the No-Build alternative, any improved bus service would compete with rail service. It may be most realistic in this study to assume that the existing bus terminate in Medway rather than Milford for all alternatives. However, no change in bus service would be made on the portion of the line through Medfield and Westwood.

Bus Alternative Summary

With the exception of Worcester to Boston non-stop service, existing bus service is extremely limited in much of the study area. With improvements in both service frequencies and park and ride facilities, bus services should be able to capture a greater share of the increasing number of work trips to Boston. For this analysis, it is assumed that there will be no change in off-peak headways. Proposed improvements in each existing route are summarized in Table 2-5.

TABLE 2-5
PROPOSED SERVICE UNDER ALL BUS ALTERNATIVE

To Boston from:	Existing Peak Headway	Proposed Peak Headway	Park and Ride Locations[1]	Current Fare	Proposed Travel Time
Hudson/Marlborough via Routes 85, 30, (Express from Exit 12 I-90 to Boston)	1 trip	30 minutes	Hudson - 29 spaces	$4.00	75 min.
			Marlborough - 114 spaces	$3.50	60 min.
			Southborough - 70 spaces	$3.00	50 min.
Worcester "Semi-Express" via Route 9 (Express from Exit 12 I-90 to Boston)	2 trips	30 minutes	Shrewsbury - 50 spaces	$4.05	65 min.
			Westborough - 74 spaces	$4.05	55 min.
Worcester Express via Route 122 (Express from Exit 11 I-90 to Boston)	30 minutes	30 minutes	Worcester or East Millbury - 75 spaces [2]	$6.00	65 min.
Milford	30-50 minutes	No Service			

All proposed services will distribute passengers to Back Bay and South Station during peak hours.

[1] Number of spaces is estimated minimum for bus riders only; additional spaces may be needed to accommodate ridesharing (carpools and vanpools).

[2] Assumes patrons will be drawn from Worcester, Millbury, Grafton.

[3] Assume rail service is via Franklin Branch.

CHAPTER 3

EXISTING RIGHT-OF-WAY CONDITIONS AND REQUIRED IMPROVEMENTS

The Worcester to Framingham Conrail main line, the Providence and Worcester line from Worcester to Millbury, the Marlborough branch and the Milford Branch were field inspected by sampling roadbed, tie and rail at pre-selected sites along the lines as well as the bridge and culvert structures. This chapter details the existing right-of-way conditions and outlines the improvements required to institute commuter rail service. For right-of-way layout of the main line and branch lines refer to the maps presented in Appendix A.

The existing right-of-way of all three lines is currently in service, at least in part, for freight operations. Currently Conrail operates three TrailVan (TV) piggyback trains in each direction on the Worcester main line. Additionally, one general freight train and several local trains traverse the segment. One train has been operating from Selkirk (Albany, N.Y.) to the General Motors automobile assembly plant in Framingham, but with the plant's closing, its continuation is doubtful. Amtrak operates two intercity passenger trains to and from New Haven and one to and from Albany daily. A yard in Framingham serves as base for local trains on this line and the other branches. At Westborough, Conrail maintains a large automobile unloading facility. It is believed that this facility is about to undergo a major expansion, perhaps doubling in size. Much of the territory through which the line passes is wet, as large numbers of ponds, streams and wetlands are present.

The Providence and Worcester runs a "short-line" type of operation with very light traffic.

The Marlborough branch line is used for local freight service and is adequate for lower speed freight. A substantial part of the traffic on the Marlborough branch is thought to be a hazardous commodity, LPG gas.

The Milford branch line maintains freight service, but for only a portion of the proposed commuter operation. The line has been cut back to milepost 7.0, near Chicken Brook in Holliston, with track remaining in place but out of service for approximately 3 more miles. The last portion under Interstate Highway 495 and into Milford has no track in place. The portion under the highway has lost its grade and is flooded. There is significant encroachment to the right-of-way in Milford proper. The customer at milepost 7.0 operates a transfer facility for various chemical products. Until very recently, the Milford branch was the site of the General Motors automobile assembly plant, located within Framingham, a short distance from the main line. With the closing of this plant the traffic volumes on the branch will likely decrease.

The current condition of each of the lines is adequate for the current service. The branch lines are somewhat superior to what might be expected of lightly used lines. Rehabilitation to bring the lines to passenger standards would be required on both branch lines, while some changes in the main line are required as well. In the following sections each line will be treated in turn, with current condition and expected rehabilitation plan outlined.

3.1 ROADBED AND TRACK

Worcester Line (22.9 miles)

The segment is very well maintained at present. Conrail freight trains operate at 50 mph and Amtrak at 60. From Framingham to Westborough, approximately 12 miles are double track, but beyond Westborough all former second track has been taken out of service. Much of it has been physically removed and the remainder is scheduled for removal this year. For approximately the last 3 miles, from milepost 40.3 to Worcester yard, the second track remains in place and is used as a non-controlled siding for industry service and yard access. At the current Worcester Amtrak station, the remnant of the second track is in place, but appears to be out of service. Freight traffic apparently uses a yard track to pass through the Worcester yard and station area, rather than the main used by the passenger trains. A junction and interchange with the Grafton and Upton shortline is located on the main line near North Grafton, apparently generating little volume.

The signal system on this line was recently upgraded to a modern, electronic system with cab signals.

Rehabilitation on this segment would not be necessary as the current plant is in acceptable condition. Welded rail is currently in place on this line. In order to facilitate train operations, restoration of double track from Westborough to Worcester as discussed in Section 6.6 is recommended. This new track is estimated to be nine miles in length and incorporate 132 pound welded rail. A layover facility has been estimated at the end of this line to avoid deadheading. A detailed estimate of materials and construction costs is included in Section 3.5.

Worcester to Millbury Extension (4 Miles)

This segment is a non-signaled, lightly used line, owned and operated by the Providence and Worcester Railroad (P&W). The track consists of 115 and 107 pound rail, cinder ballast, and ties in fair condition. The connection track between Conrail and the P&W is 100 pound rail. Portions of this segment have mud covering the ballast and vegetation growing within the rails. Some of the rail is bent at the joints due to years of operation with poorly supported ties. The track would require complete rehabilitation.

Milford Branch (12.3 miles)

This branch is in service only from Framingham to milepost 7.0 at Chicken Brook in Holliston, a distance of about 7 miles. Beyond milepost 7.0, the track is in place for an additional 2.8 miles, but the line is currently out of service. Beyond that point no track exists. A small portion of the right-of-way (about .3 miles) in the area of the I-495 underpasses is severely deteriorated and extensively flooded. The last part of the proposed line in Milford has existing right-of-way but it has been recently regraded and there is encroachment by adjoining property owners.

There is a large General Motors automobile assembly plant located in the immediate Framingham area on this line. It incorporates a large yard facility and an automobile unloading ramp as well. The plant has very recently been closed and is not expected to be reopened. The auto unloading facility's future is uncertain, particularly given the proximity of the major facility at Westborough, although Conrail has been seeking to expand its capacity recently. Although this facility may be available for use in connection with the commuter service, its condition was not ascertained in our observations.

The active portion of the line has light weight rail and a posted 10 mph speed limit. It appears that service beyond the automobile plant was on an as needed basis. The only observed customer on the line was a chemical transfer facility located at the end of active track in Holliston.

Rail on the line is 100 and 105 pound jointed and is in fair condition for the service. Ties are better than adequate with recent work in evidence in some areas. The rail is built up on cinder sub-ballast with a recently added top dressing of stone ballast.

Approximately 27 percent of ties are not suitable for passenger service and would require replacement. However, since the field survey was performed, it appears that a Conrail tie renewal program is being implemented. We have estimated rehabilitation costs using new 132 pound CWR and the estimate is incorporated in Section 3.5. A two mile passing siding would be necessary for the maintenance of 30 minute headways as specified in the plan.

Extensive grading and filling would be required in the area of the I-495 underpasses and the source of the flooding controlled. It was not possible to examine this area closely due to the water level at the time of our visit. More detailed engineering work is certainly required here. In the Milford area where encroachment has occurred, it would be necessary to do further analysis to determine the current status of the property necessary for the service.

A layover facility has been estimated at the terminal station location to avoid deadheading on this branch.

Marlborough Branch (10.4 miles)

The Marlborough Branch, like the Worcester main line, is currently in service for freight traffic which is light and consists of local train service. The line is fully adequate for 25 mph freight traffic, but it is not adequate for passenger service and would require considerable rehabilitation. The expected end of the line for commuter service is in the area of the Interstate 495 crossing. The current rail on the line is 107 pound New Haven rolled between 1920 and 1927 except for a small (approximately one and one half mile) segment of 131 pound continuous welded rail (CWR). Ties are in generally better than average condition for the current service. There is evidence of recent tie work and cinder

About 33 percent of existing ties should be replaced for passenger service. Rail should be replaced with CWR. We have prepared estimated rehabilitation costs for new 132 pound CWR, and included them in Section 3.5. A passing siding similar to that for the Milford branch would also be necessary on this line. The line would require additional ballast and surfacing work in connection with the tie and rail work.

A layover facility at the terminal station location has been included to avoid deadheading on this branch as well.

3.2 BRIDGES AND CULVERTS

Introduction

The majority of bridges and culverts were examined in the field and deficiencies in structural performance as well as required horizontal and vertical clearances were noted. Additional information for several of the bridges carrying highways over the railroad was obtained from the Massachusetts Department of Public Works (MDPW). This section describes the general condition of the structures, unique deficiencies and suggested repairs. Additional field surveys and design engineering will be required to assess load carrying capacity and to more precisely determine the required repairs for these structures. For locations of bridges and culverts, refer to Appendix A maps.

Load carrying capacity of the highway structures was obtained from signs posted on the structure approaches or from MDPW supplied data. These capacities indicate either a single gross truckload, "10 tons," or three different tonnages relating to standard truck configurations, "10/15/19." Railroad structure capacities are based on the "Cooper's Loading" which is a standard engine configuration followed by a uniform freight car loading. These capacities were not available for this study but need to be determined before the commuter lines can be restored. However, visually obvious deficiencies are noted in the following sections as well as those structures that appear incapable of carrying full design loadings.

Statutory horizontal clearance from centerline of track to appurtenances is eight feet, six inches. Those structures near or below this minimum are noted. In all cases, necessary horizontal clearance for one track can be obtained by slightly shifting the alignment; however, a second or siding track may not be feasible within the existing horizontal limits. Vertical clearance of twenty-two feet, six inches is required for new structures over railroads. This requirement is met by very few of the structures. However, the Department of Public Utilities usually allows restoration meeting existing vertical clearances to proceed without requiring new variances. For a commuter line sixteen feet, five inches is required and eighteen feet is desired to accommodate future electrification. The eighteen foot requirement is met in all cases except on the Marlborough Branch as noted below.

Virtually all of the structures are in need of minor repairs and/or maintenance work to prevent further deterioration and extend the structure lives. All steel superstructures of railroad bridges require cleaning and/or sandblasting and painting. Concrete superstructures and substructures require spall patching, crack filling and in some cases, expansion joint repair. The majority of bridge substructures and culverts are granite block and are in need of pointing. The specifics of these items of work are not noted below; however, estimated expenditures are included in the cost summary.

Worcester Line

Structure B-WC-2 carries Winter St. over the railroad in Framingham. A concrete deck on rolled steel beams is supported by granite block abutments. Cast-in-place concrete below the beam bearings indicates that this superstructure was raised approximately one foot, six inches many years ago and another one foot, six inches recently. During the recent work, tiebacks were installed through the abutments and wingwalls to minimize any stress increases resulting from the increase in height and approach roadway fill (see Figure 3-1). A crack has developed in the southwest wingwall and abutment that indicates movement in the direction of abutment overturning. Survey markings are present, presumably installed by Conrail to monitor the movement and crack width. Monitoring should continue.

Structure B-WC-9 carries the railroad over Route 85 in Southborough. The bottom flange of the exterior girder and sections of the lateral bracing have been damaged by impact with highway vehicles from below.

Structure B-WC-21 carries the railroad over Arch Street in Westborough. The majority of the superstructure is concrete encased riveted steel girders with heavy efflorescence and spalling around the girders.

Structure B-WC-23 carries Pine St. over the railroad in Grafton. Similar to the previous structure, it has been recently raised, tiebacks have been installed and cracks indicating movement are present. The southern abutment should be monitored for future movement.

Structure B-WC-25 carries the railroad over a waterway connecting Flint Pond with Hovey Pond, in Grafton. This twenty-two foot clear span granite arch is cracking and shows loss of arch action by movement of the bottom courses of granite above the opening. Remedial action has been attempted by the installation of a truss on each side of the arch connected by through bolts. The top chord of the truss consists of two pieces of timber ties, butt spliced at the centerline. In plan, these top chords are bowed which indicates movement subsequent to the truss installation (see Figure 3-2). This structure should be monitored for additional movements.

Structure B-WC-27 is a cast-in-place concrete parabolic arch structure carrying the railroad over Sunderland Road in Worcester. Heavy spalling and exposed reinforcing steel on the underside of the arch should be repaired.

Horizontal clearance is not a problem except for Structure B-WC-23 which measures seven feet, nine inches to the centerline of the active track. For this structure a total horizontal clearance of over twenty-seven feet exists between abutments and therefore one track could easily be accommodated with a slight shift in horizontal alignment.

Many superstructures have been raised recently to obtain a twenty foot vertical clearance above the top of rail. These structures are indicated in the table, some with two entries for the vertical clearance; one entry for the new clearance and one entry for the clearance which existed prior to the recent work. Most structures also had tiebacks installed similar to Structure B-WC-2. Structure B-WC-7, Howe St. over the railroad in Ashland, had its superstructure removed but there is a utility spanning between abutments that has recently been raised to twenty feet clear. Structure B-WC-15, Holmes St. over the railroad in Westborough, appears to have been closed with the superstructure removed for a substantial length of time. This is also true of Structure B-WC-22, Asylum Crossing over the railroad in Grafton, which appears to be on the private property of Tufts University. Tiebacks have been installed on this structure's abutments indicating that the superstructure will be reinstalled.

Milford Branch

Structure B-MF-1 carries Whitney St. over the railroad in Sherborn. This structure is a timber deck on steel stringers supported by granite stone abutments and wingwalls. The wingwalls have been mortared and a crack indicating movement exists at the top of the southwest wingwall and abutment. This crack should be monitored for movement.

Structure B-MF-2 is an eight span granite stone arch structure over Jar Brook in Holliston (see Figure 3-3). The wingwalls show movement and will require repair. The remainder of the structure is in good condition although, because of the size of the structure, the typically minor repair of pointing will be a major expense.

Structure B-MF-5, carrying Highland St. over the railroad in Holliston, is a granite horseshoe-shaped arch structure with large granite wingwalls. There is approximately twenty feet of fill above the structure, of which fifteen feet was added at some time after construction (see Figure 3-3). Large movements are apparent in the wingwalls and, at a minimum, these wingwalls need repair with tiebacks or replacement. The clearances are sixteen feet, six inches vertical and fourteen feet, ten inches horizontal and may be a concern, based upon the actual clearances required. There is also standing water on the railroad approaches requiring that the drainage in the area be improved.

Two cast-in-place box culverts, Structure C-MF-6 and Structure C-MF-7, exhibit spalling at the inlet and exit and substantial efflorescence dripping from the top slab. These structures will need replacement including the four, twenty to thirty foot long wingwalls of Structure C-MF-7.

There are also standing water and drainage problems under Structures B-MF-6 which carry 1-495 over the railroad in Milford. Raising the grade and improving drainage to install the trackbed may present problems since the vertical clearance from bottom of structure to present grade is approximately twenty feet.

Although there is no present structure, the intersection of Route 109 and the railroad would require substantial structural cost if the commuter line extends to this point. There was a grade crossing at this location and subsequent to the abandonment of the railroad, Route 109 has been raised eight to ten feet to improve highway sight distance and design speed. The apparent solution to this crossing is a highway structure over a depressed railroad which would include extensive wingwalls, retaining walls and drainage improvements.

Marlborough Branch

Structure B-MB-7 is a highway bridge carrying the connector road between Route 9 and Route 30 over the railroad and highway. The span over the railroad consists of through steel plate girders supported by a cast-in-place pier and abutment. The concrete pier is heavily spalled adjacent to and partially under the bearing plate for the through girder (see Figure 3-4). The drainage should be diverted and the bearing area repaired. Several floor beams also bear directly on the pier and require similar repair.

Structure C-MB-2 is a culvert beneath the railroad composed of granite stone headwalls and wingwalls. The south headwall has overturned and the fill is settling. The overturning has also exposed the top of the structure which consists of short sections of rail, side by side, with mortar cast between the rails. A few of these rails have slipped off their bearings due to the movement of the fill (see Figure 3-4.) Further engineering is required and, at a minimum, the south headwall and top slab should be repaired.

Structure C-MB-3 is similar to structure C-MB-2 and, at a minimum, headwall repair is necessary.

There are two structures that have less than eight foot, six inches of horizontal clearance to the track centerline. Both of these structures have sufficient horizontal clearance to provide the required width by shifting the horizontal alignment. Structure B-MB-11 has an existing eight foot clearance to centerline with an overall clearance of twenty-nine feet. Structure B-MB-13 has an existing eight foot, three inch clearance to centerline with an overall clearance of twenty-seven feet.

Cost Summary

Tables 3-5, 3-6, and 3-7 contain cost estimates for repair of the bridge and culvert structures. Although existing conditions and required repairs for highway structures as well as railroad structures are discussed in the text, only those costs associated with railroad structure repairs are tabulated, since all highway structures requiring repair have been checked against the MDPW inventory listing, which reveals that the owner and custodian in all cases is either the MDPW or the COE/Fed. The column labeled "Required

Repairs" are those deemed necessary to repair the structures to allow safe operation of the commuter rail. As noted previously, carrying capacities of the railroad structures was not available for this study, but must be determined before the commuter rail could be put into operation. The column titled "Maintenance Repairs" contains repairs necessary to stop the present deterioration and to extend the life of the structures.

For those structures where severe deterioration was noted in the field, replacement costs have been shown as required repair costs. Further study is necessary to determine if the structures could be satisfactorily repaired to safely carry the commuter rail line.

3.3 GRADE CROSSINGS

Proposed modifications to grade crossings are based on the MBTA standard of providing automatic flashers and gates at all public grade crossings. New crossbucks and stop signs are provided at private crossings. In addition, public crossings will be provided with rubber surfaces and private crossings replaced with new timber crossings.

Worcester Line

There are only three main line grade crossings on the Conrail line, one of which requires modification. The grade crossings, listed sequentially from Framingham to Worcester, are as follows:

	Crossing	Existing Protection	Proposed Modification
Ashland	- Main Street	Auto Flasher & Gates	No change
	- Cherry Street	Auto Flasher & Gates	No change
N. Grafton	- Parmenter Crossing	Auto Flasher	Add Gates

Worcester to Millbury Extension

Three public grade crossings were surveyed on the Providence and Worcester Line. One crossing (McCracken Road) is just beyond the expected project limits, so it is not considered for modification in the development of a cost estimate. The grade crossings on this line are listed sequentially from the Conrail Junction to Millbury as follows:

	Crossing	Existing Protection	Proposed Modification
Worcester	- Millbury St. (North)	Flashers	Add Gates
	- Millbury St. (South)	Cross Bucks	Install Gates & Flashers

Milford Branch

There are eighteen grade crossings located on the proposed commuter rail service line from Framingham to Milford. The grade crossings together with proposed modifications (listed sequentially from Framingham to Milford) are as follows:

	Crossing	Existing Protection	Proposed Modification
Framingham	- Waverly St.	Auto Flasher	Add Gates
	- Claflin St.	Auto Flasher	Add Gates
	- Hollis St.	Auto Flasher	Add Gates
	- Waushakum St.	Auto Flasher	Add Gates
Holliston	- Washington St.	Cross-bucks	Install Auto Flasher & Gates
	- Private Crossing	N/A	Install new cross bucks and stop signs
	- Lowland St.	Cross-bucks	Install Auto Flasher & Gates
	- Private Crossing	N/A	Install new cross bucks and stop signs
	- Private Crossing	N/A	Install new cross bucks and stop signs
	- Church St.	Cross-bucks	Install Auto Flasher & Gates
	- Central St.	Cross-bucks	Install Auto Flasher & Gates
	- Private Crossing (Metcalf's)	N/A	Install new cross bucks and stop signs
	- Cross Street	Cross-bucks	Install Auto Flashers & Gates
	- *Rte. 126	Cross-bucks	Install Auto Flashers & Gates
	- *Chestnut St.	Cross-bucks	Install Auto Flashers & Gates
	- *Hopping Brook Rd.	N/A	Install Auto Flashers & Gates
	- *Smith St.	N/A	Install Auto Flashers & Gates
	- *South St.	N/A	Install Auto Flashers & Gates

*Track has been abandoned in places or removed at these locations.

Marlborough Branch

There are currently six public grade crossings on the proposed commuter rail service line from Framingham to Marlborough. The six grade crossings from Framingham to Marlborough, together with the proposed modifications are listed below.

	Crossing	Existing Protection	Proposed Modification
Framingham	- Maple St.	Auto Flashers and Gate	No Change
	- Salem End Rd.	Auto Flashers and Gate	No Change
	- Rte. 9	Auto Flasher	Install Gates
	- California Ave.	Cross Bucks	Install Auto Flasher & Gates
Southboro	- Oak Hill Rd.	Auto Flasher	Install Gates
	- Main St. (Rte. 30)	Auto Flasher	Install Gates
	- Private Crossing	N/A	Install new cross-bucks and stop sign

3.4 SIGNALS AND COMMUNICATIONS

Estimates for signal costs include snow melters for all power operated turnouts, and both wayside signals and cab signals. Costs for upgrading highway crossing warning devices are listed separately. The general plan for signalling is shown in Figure 3-8. Automatic signals are not shown for clarity.

Worcester Line

From Westborough out to Worcester (and on to Albany), Conrail has recently installed a new fully electronic state-of-the-art signal system. This is a Centralized Traffic Control (CTC) system which conforms to Traffic Control System (TCS) rules of the Federal Railroad Administration (FRA). This system has cab signals without wayside signals, except at interlocking locations where wayside home signals exist. This territory is remote controlled from Selkirk, New York.

Any passenger trains on this route would be required to be equipped with cab signals. Because of the lack of wayside automatic signals, trains with cab signals failed or inoperative would face significant delays because of special operating rules that would be followed.

Because of this requirement for cab signals, it has been assumed that all lines under consideration in this report have cab signals. Cab signal test facilities have been included in the estimates for Milford, Marlborough and Worcester (on the P&W).

To run a rush hour service as well as off peak service, it is required to add a second track out to Worcester. A single passing siding instead of double track would suffice for rush hour service only. Further discussion on the operating analysis used to establish these requirements is contained in Chapter 6 and Appendix C.

The signal system was estimated both ways; with the passing siding and with double track. Certain industry sidings are currently accessed by Conrail from the former second main track which is now a secondary track. The signal estimate for two tracks includes two electric locks to access those sidings directly from the second main track as required under FRA rules for TCS systems. The difference in the signal costs are minimal; the track costs are, of course, higher for the double track alternative. Also included in the estimate is a layover facility with power operated turnouts.

Worcester to Millbury Extension

A new signal system is estimated for approximately five miles from the interface with Conrail south to the Massachusetts Turnpike (Interstate 90). Cab signal test facilities are included.

At the interface with Conrail, a power operated turnout exists to provide access to the Providence & Worcester (P&W). However, the existing three track layout on the P&W is such that a train would have to proceed through two crossovers to get to the north side of the railroad where it station is proposed. Therefore, the cost estimates for this segment include the costs of power operating these two crossovers and remote controlling them.

Because the P&W has no signal system today (except for a few highway crossing flashers), introducing a signal system and a control machine (which would have to be manned around the clock) is not without problems. It is recommended that the MBTA or Conrail control the crossovers from an existing control machine and maintain the signal system. The cost estimate is based on that scenario. Alternatively, the MBTA could purchase that portion of the P&W. The signal estimate contained herein would not change. The purchase cost is not included in this report.

Milford Branch

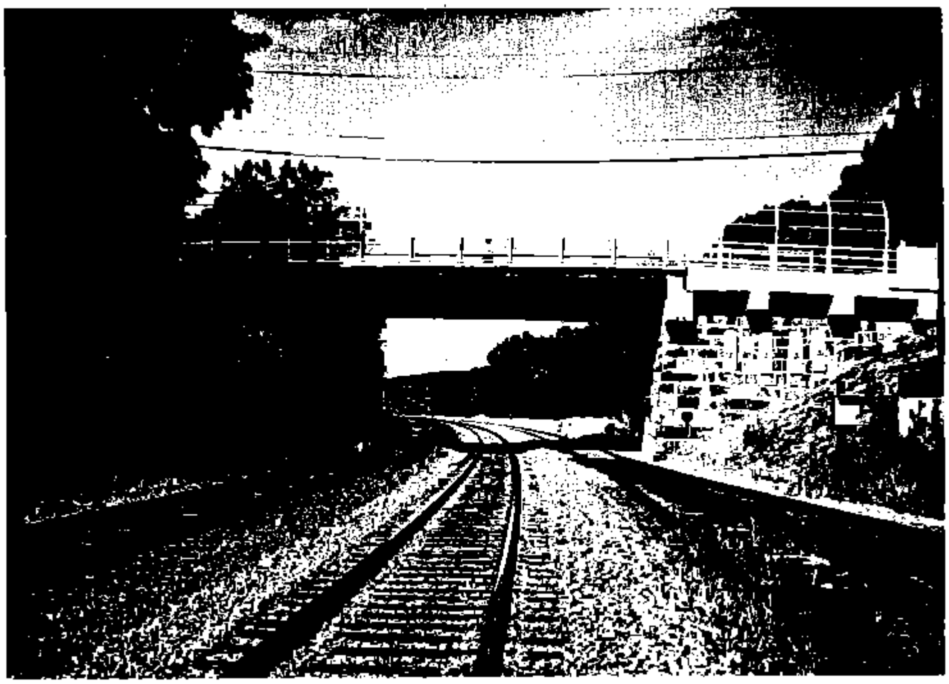
This line is currently non-signaled. The estimate for this line includes the cost of a control machine at a site of the MBTA's choosing. Also included is a layover facility with power operated turnouts on the east end only, and a two mile remote controlled siding.

Marlborough Branch

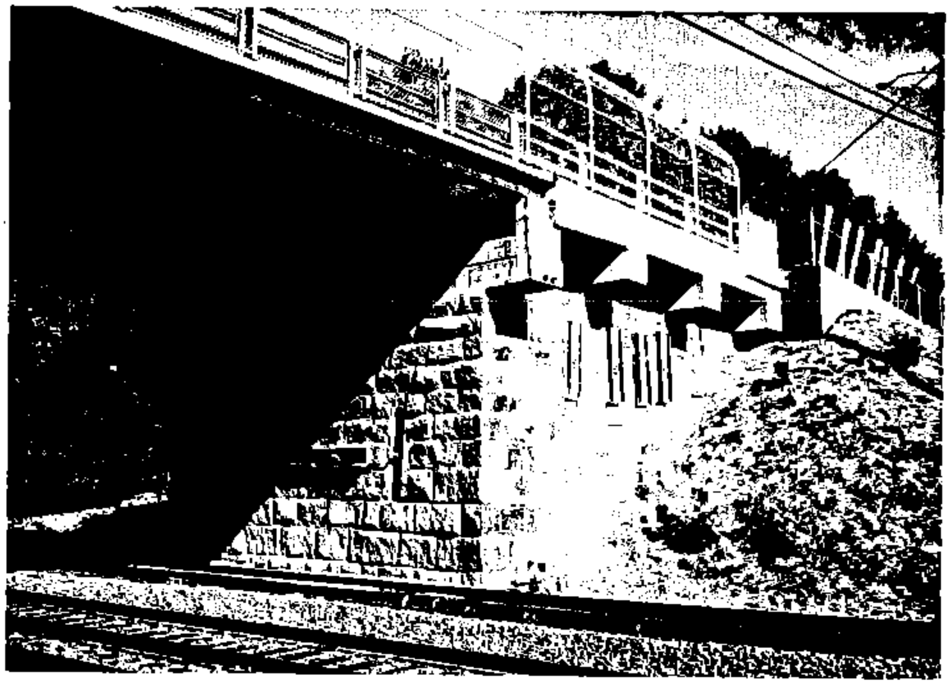
This line is also non-signaled. The estimate for this line includes the cost of a control machine at a site of the MBTA's choosing. Also included is a layover facility with power operated turnouts. A power operated, remote controlled, two mile siding is included in the estimate. Depending on the operating scenario of hand thrown switches, electric locks may be required. An electric lock is estimated for freight use of hand thrown switches.

3.5 CONSTRUCTION COSTS

The costs associated with the construction and upgrading of various components of the right-of-way infrastructure between Framingham and each of the proposed commuter rail termini have been itemized and presented in Table 3-9. A 20 percent contingency factor has been added to the capital cost subtotals to derive the total estimated costs. Appendix B provides back up detail on the specific quantities, unit costs, lump sum allowances and significant assumptions used to derive the right-of-way upgrading costs.

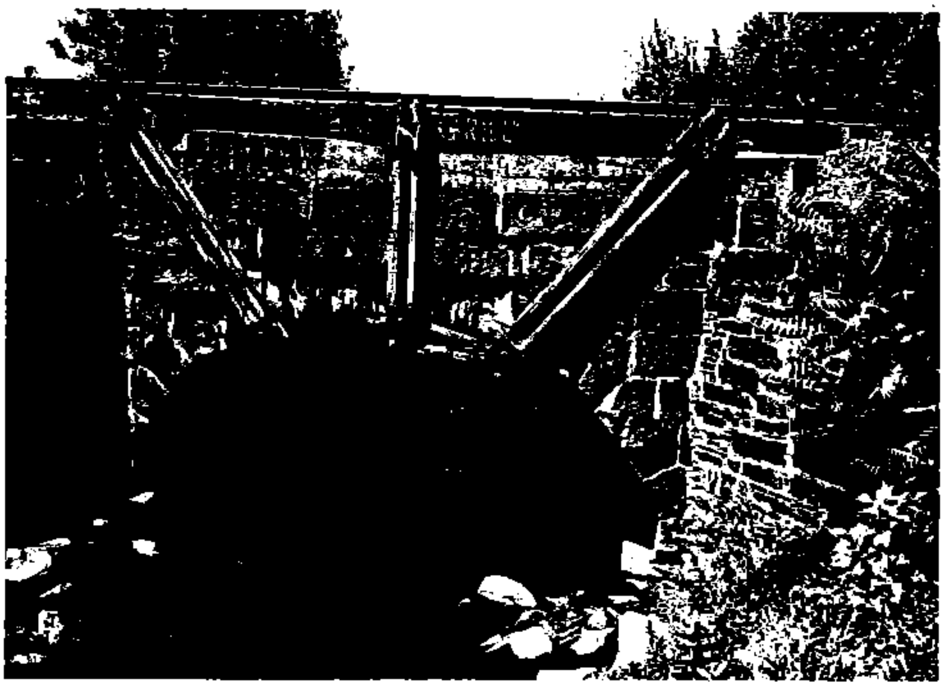


STRUCTURE B-WC-2
RAISED SUPERSTRUCTURE AND WINGWALL TIEBACKS

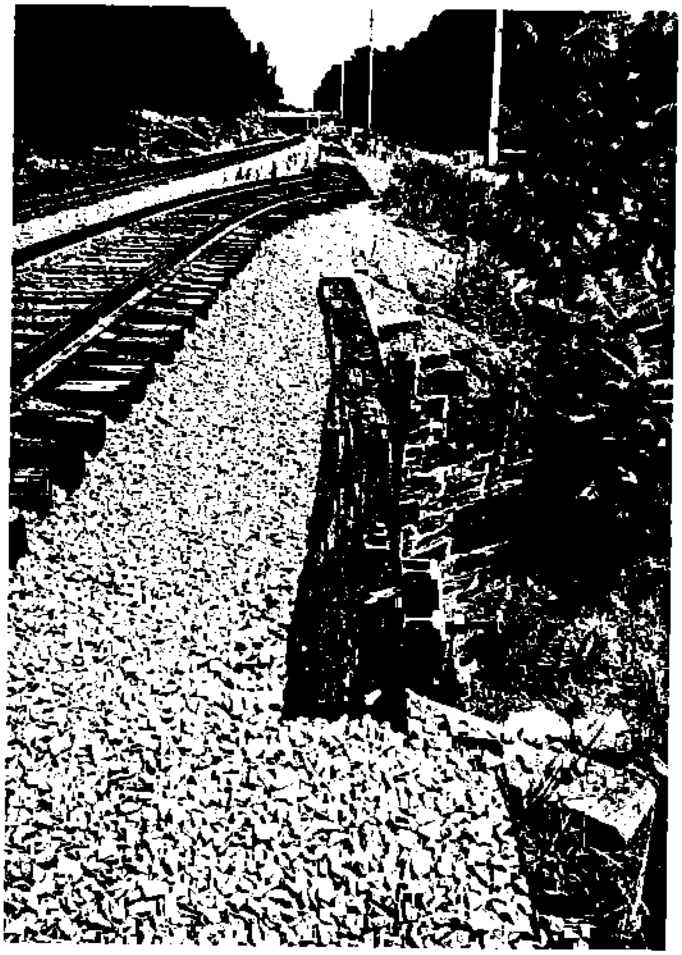


STRUCTURE B-WC-2
RAISED SUPERSTRUCTURE WITH ABUTMENT AND WINGWALL TIEBACKS

FIGURE 3-1

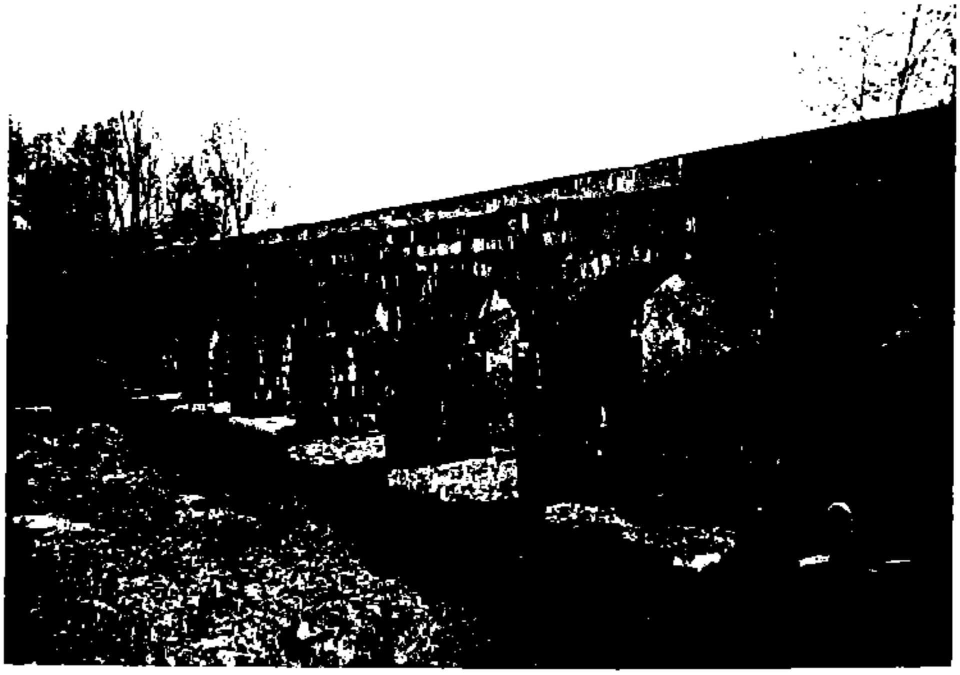


STRUCTURE B-WC-25
ELEVATION

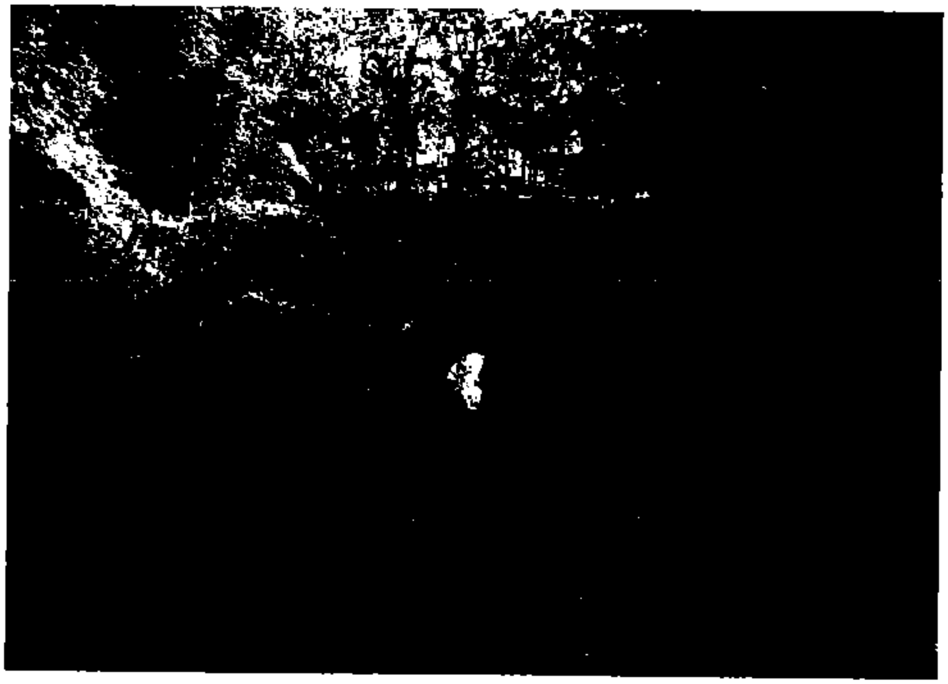


STRUCTURE B-WC-25
BOWED TOP CHORD OF REPAIR TRUSS

FIGURE 3-2

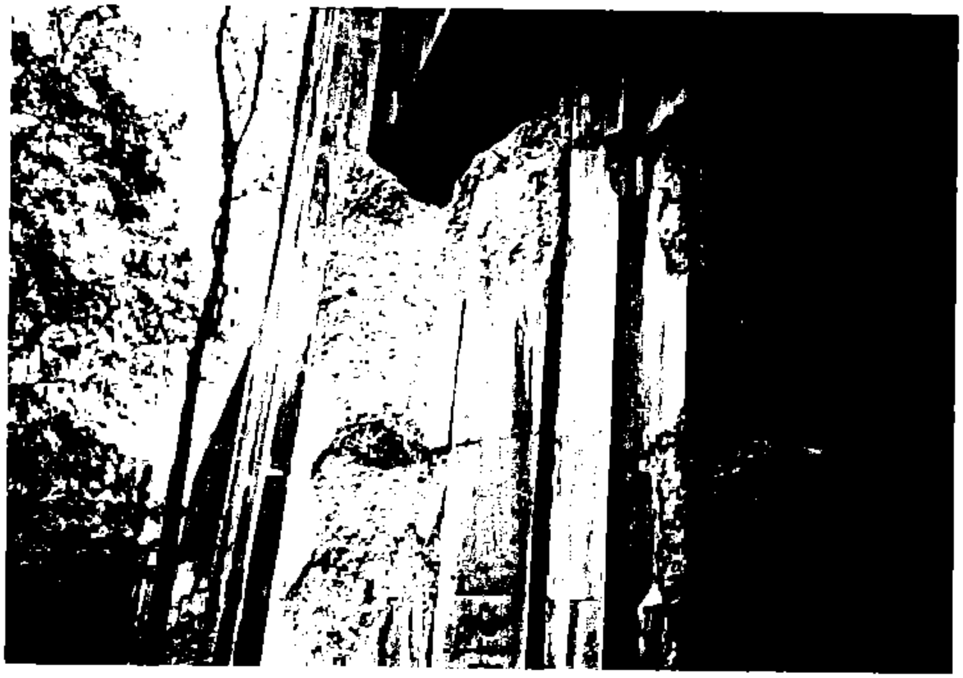


STRUCTURE B-MF-2
ELEVATION



STRUCTURE B-MF-5
ELEVATION

FIGURE 3-3



STRUCTURE B-MB-7
SPALLING AT PIER BELOW THRU-GIRDER BEARING

STRUCTURE C-MB-2
HEADWALL OVERTURNED AND RAILS USED AS TOP DECK

FIGURE 3-4

TABLE 3-5

STRUCTURE REPAIR COST SUMMARY
WORCESTER LINE
(1989$)

BRIDGE I.D.	REQUIRED REPAIRS	MAINTENANCE REPAIRS
B-WC-03	$ 0	$ 9,000
C-WC-01	0	6,000
B-WC-06	0	2,000
B-WC-09	11,500	29,500
B-WC-14	0	6,000
B-WC-16	0	3,500
B-WC-18	0	22,000
B-WC-21	104,000	5,500
B-WC-25	172,000	0
B-WC-26	0	73,500
B-WC-27	25,500	0
B-WC-30	0	37,500
B-WC-33	0	21,500
B-WC-34	0	11,000
B-WC-35	0	61,500
B-WC-36	0	50,500
B-WC-37	0	56,000
B-WC-40	0	5,500
B-WC-41	0	6,500
B-WC-43	0	52,500
B-WC-47	0	7,000
B-WC-48	0	4,500
TOTALS	**$ 313,000**	**$ 471,000**

TOTAL STRUCTURE REPAIR COST FOR THE WORCESTER LINE: **$ 784,000**

TABLE 3-6

STRUCTURE REPAIR COST SUMMARY
MILFORD LINE
(1989$)

BRIDGE I.D.	REQUIRED REPAIRS	MAINTENANCE REPAIRS
B-MF-02	$ 43,500	$ 35,000
B-MF-03	0	4,500
B-MF-04	0	1,500
C-MF-06	61,500	0
C-MF-07	110,500	0
C-MF-11	0	1,500
TOTALS	**$ 215,500**	**$ 42,500**

TOTAL STRUCTURE REPAIR COST FOR THE MILFORD LINE:	**$ 258,000**

TABLE 3-7

STRUCTURE REPAIR COST SUMMARY
MARLBOROUGH LINE
(1989$)

BRIDGE I.D.	REQUIRED REPAIRS	MAINTENANCE REPAIRS
B-MB-02	$ 0	$ 42,500
B-MB-04	0	11,000
B-MB-06	0	21,500
B-MB-08	0	13,000
C-MB-02	11,000	0
C-MB-03	3,500	0
C-MB-12	0	10,500
TOTALS	**$ 14,500**	**$ 98,500**

TOTAL STRUCTURE REPAIR COST FOR THE MARLBOROUGH LINE:	**$ 113,000**

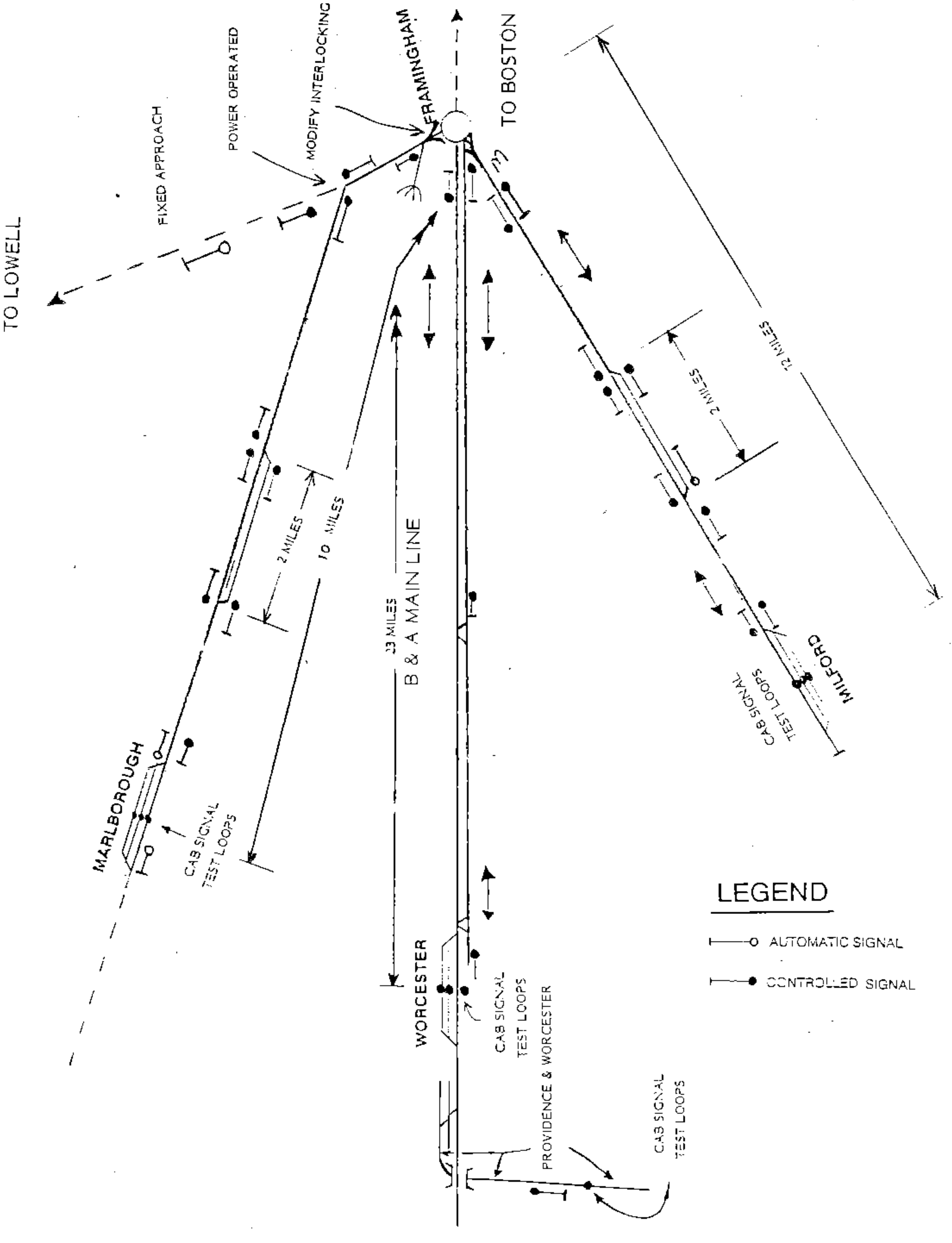


FIGURE 3-8

MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

WORCESTER/MILFORD/MARLBOROUGH
COMMUTER RAIL EXTENSION
FEASIBILITY STUDY

SIGNAL SYSTEM
LAYOUT

TABLE 3-9
CAPITAL IMPROVEMENT COSTS
(Thousands)
(1989$)

Item	Worcester Line [a] [b] (to Worcester)	Milford Branch	Marlborough Branch
Track	0	6901	5799
Passing Siding	5191 [c]	1822	1295
Grade Crossings	100	1300	490
Layovers	2214	2214	2214
Signals [d] [e]	2752	2566	3057
Bridges & Culverts	652	258	113
Subtotal	10909	15061	12968
Contingency (20%)	2182	3012	2594
Total	13091	18073	15562

[a] Extending the Worcester Line to one of the three potential station sites beyond the Worcester Amtrak site adds $1,443,800 to signal costs, $1,500,000 - 2,400,000 to track and grade crossing costs and $120,500 - 132,000 to bridge and culvert costs.

[b] If the Worcester Line were only extended to Westboro (I-495) as an interim step, the capital improvements required to the right-of-way would be reduced from $13.091 Million to $4.946 Million.

[c] Assumes adding a second track from the end of the existing second track in Westboro to Worcester.

[d] Total signalling costs for Alternative 3 which provides service to both Marlborough and Milford is approximately $243,000 less than the summation of the individual signalling costs for each line.

[e] If midday storage is to be provided at either Milford or Marlborough, reverse signalling (TCS) to track 1 from CP 11 to Framingham, should be provided at an additional cost of $712,400.

CHAPTER 4

STATION ALTERNATIVES

4.1 STATION SELECTION CRITERIA

Due to the lack of functioning stations along the studied rail lines, possible new station locations were researched. A list of potential sites was developed through site reconnaissance and other available information. Each site was then characterized as to key issues and opportunities. These issues included land use and availability, zoning codes, public policy issues, traffic and handicapped accessibility, and station operational requirements. The detailed criteria used to evaluate these sites are listed below:

Site Capacity

- Sufficient area to accommodate a 730 ft. long platform and associated needs.
- Immediate, and appropriately convenient, access.
- Parking area to accommodate 250 to 500 car minimum commuter usage.
- Maximum opportunities for expanding the site to meet potential future needs.

Site Condition

- Appropriateness of siting with respect to horizontal and vertical track geometry.
- The accommodation of parking levels based on the existing grades and their overall relationship to the station siting.
- Proximity and effect of siting on sensitive environmental areas such as wetlands or aquifer zones.

Community Issues/Impact

- Appropriateness of siting in relationship to neighboring land uses.
- Availability of land holdings for parcel acquisition.
- Noise, vibration and air quality.

Access

- Siting which allows secondary road access feeding off major highway/materials.
- Accommodation of required traffic volumes with minimum adverse impacts.

Capital Costs

- Minimal acquisitions of independently owned parcels.
- Minimal requirements for developing new infrastructure.
- Minimal grading and drainage requirements.
- Minimal demolition of existing structures.
- Minimal new structure construction.

General Conditions

- Accommodation of pedestrian users with adequate consideration given to access, movement and overall safety within close proximity of the rail lines.
- Designating a site which provides ease of access by wheelchair users and others with mobility limitations.

4.2 SUMMARY OF ALTERNATIVES AND SITE DESCRIPTIONS

Extending commuter rail service requires consideration of new commuter stations in Ashland, Westborough, Grafton and Worcester on the Worcester line, Holliston and Milford on the Milford line, and Framingham and Southborough on the Marlborough line. Potential sites serving each community have been investigated and in this section those sites are generally described. In section 4.3, the preferred location in each community is more fully analyzed. Site and locus plans appear at the end of this chapter for preferred sites and in Appendix Aa for non-selected locations.

Worcester Line Options

Ashland

The Ashland sites are located in the town center and west of town center along the Sudbury River. Routes 85 and 135 frame western and eastern highway boundaries with I-90 forming a northern edge.

Ashland Center: This is the site of a previous rail station, and therefore it already meets some of the required criteria. The site is located in an area zoned Commercial - B. The land uses are a mixture of institutional and retail. The institutional uses include a post office and library. The retail uses are mixed but include gas stations and eateries. Beyond the site, land uses are primarily residential. It is an acceptable site with adequate parking. Shared use by commuters and patrons of adjacent commercial establishments must be accommodated. Access can be achieved via Route 135 to Main Street, which in turn leads to the parking lot off Front Street. (see Figure Aa-1, 2 in Appendix Aa).

Cherry Street: This is a potential site located just off of Cherry Street between the MBTA rail line and Megunko Road. It is located in an area zoned for industrial uses. Existing uses are primarily heavy industrial and auto related with scattered warehouses throughout the area. South of the station site, the landscape is wooded and to the north the predominant use is residential.

The site is adequate in size and siting for a commuter rail station. This site is approximately a quarter of a mile north of Cherry Street directly off Route 135. Both the station and its parking lot can be accessed via Cherry Street. However, access would require travel through nearby residential areas with a playground. This issue could create adverse community impacts (refer to Figure Aa-1, 3).

Howe Street: This is a potential site on Howe Street off Cordaville Road in a Commercial-A zone. The MBTA rail line is located south of the site. The site meets all requirements for developing a new station. Cordaville Road provides connections to Routes 85 and 135. This site is located approximately two and a quarter miles from Route 135 and a mile and a quarter from Route 85. Southville Road to Cordaville Road is the most direct route. From Route 135, take Main Street to Pleasant Avenue, then to Cordaville Road. Cordaville Road directly accesses Howe Street which in turn accesses both the station and the parking lot. Existing site conditions including compatible land use development make this a very appropriate site to consider (refer to Figure 4-1, 2 at the end of this chapter).

Route 85: This is a potential site on Highland Street at Route 85 in Southborough, located in an area zoned for both business and residential use. The residential zone is defined by the area west of Hammond St., the industrial zone is east of this line. This site is essentially an isolated commercial area surrounded by residential uses.

The site is relatively small with very limited capacity for expansion. River Street (Route 85) directly to the Highland Street intersection is the most accessible route to the station site (refer to Figures Aa-4, 5).

Westborough

The Westborough site area is located at the easternmost tip of Westborough and is bordered by Flanders Road and I-90 to the North and I-495 to the West. Siting in this area will target users from both I-90 and I-495. Greater drawing capability would generate the need for larger site capacities. The railroad line exists along the Hopkinton-Westborough border in this area.

Fruit Street: This site is located off Flanders Road on Southborough Road, in an area zoned for general industrial land uses. The length of the site would easily accommodate the required platform. Acquisition of a neighboring residence adjacent to the railroad and an active industrial building would be required. A conceptual modification to the I-90, 495 interchange for access to the site is presented in Figure 4-21. In the conceptional layout, new ramps are shown, in both directions, between Fruit Street and Route 495 and the Turnpike Connector. The proposed ramp system would require removal of portions of the existing Turnpike Connector. A new bridge structure over Fruit Street would also be required to accomodate the Route 495 (northbound)/Turnpike interchange. This concept provides direct access to the site to all Route 495 and Turnpike traffic. (see Figure 4-3, 4)

Grafton

These sites are located in the proximity of the northern border of Grafton (Shrewsbury/Westborough). The existing rail line, runs through the sites. Route 30 (Westborough Road) serves each site and can be directly accessed via Routes 122 and 140. The Turnpike can be easily reached from each of these sites by travelling south on route 140 and west on route 122. The siting is generally rural with some scattered residences.

Pine Street: This site is located north of Westborough Road off Pine Street in an area zoned for both office and light industrial uses. It is currently an open, wooded site isolated from any other land uses. It is the best alternative for a new station stop, as it is sufficient in size, accommodating in grade and accessible via Routes 122, 140 and I-90. Access is best via Route 140 which crosses Westborough Road (Route 30) about a mile and a half west of the site. (refer to Figure 4-5, 6).

Parmenter Crossing: This site, just north of Westborough Road off Parmenter Road, is located in an area zoned industrial. To the north of the tracks, the site is primarily wooded with some wetlands. South of the tracks are primarily residential uses. The site is adequate in size for all the needs of a new commuter station. Grading differential, however is inappropriate for both the station platform and required parking. Neighboring residential uses would also be adversely impacted by the additional traffic generated by a station stop at this location. This station is approximately three-quarters of a mile east of Route 140 along Westborough Road and can be accessed via Parameter Road. (see Figure Aa-6, 7)

Milepost 38.75: This is a linear site located near the rail line on the north side of Westborough Road, in a residentially zoned area. While platform capacity is adequate, the site is insufficient in regards to parking immediately adjacent to the platform. Overall lot capability is small and acquisition of land for parking sites would be required within a mixed but predominately residential area south of Westborough Road. Commuters would be required to cross Westborough Road to access the platform from the parking lot. The potential for expansion may be limited as a result of the neighboring land uses. This station is approximately one-quarter mile east of Route 140 along Westborough Road. (refer to Figure Aa-6, 8).

Worcester

The alternative locations in Worcester take advantage of the existing rail line used by Amtrak. Sites are located in close proximity of one another and downtown Worcester. Highway access (I-290) is reasonably provided to each and overall land use patterns are compatible.

Amtrak Station: This site under I-290 and across from Washington Square, presents good opportunities for development as a new commuter rail station. It is the site of an existing station in an area zoned for manufacturing. Several retail/commercial uses exist within proximity of this station site. The existing grading differential (the parking level is substantially lower than platform level) would require ramping. A parking deck built above the existing lot would accommodate additional parking and be used to provide level access to the platform. Handicapped parking could be located close to the platform. Additional land exists to the east which could acommodate future parking and expansion needs. Interstate 290 and Route 122 to Washington Square provide immediate access to this station site located east of the square off Shrewsbury Street. (refer to Figure 4-7, 8).

Salem Municipal Lot: This site is north of the railroad tracks and separated from them by New Salem Street, a four lane road. The station impact on neighboring land uses would be positive. The site has a business zoning classification. Several retail uses exist near the station area, in addition to some industrial buildings, the Worcester Public Library and the YWCA. Current use of the site as a parking lot serving neighboring commercial establishments would have to be considered and conflicts between commerical parkers and commuters avoided. In addition, the potential for expansion is limited by the highway and neighboring developments. Also critical, however, would be the need to bridge New Salem Street to join a new station platform with its associated parking. This is also accessed via Washington Square by travelling a little more than a quarter of a mile west along New Salem Street, to the Myrtle Street intersection. Route 122A, (Madison Street) which is approximately an eight of a mile from Myrtle Street. provides access to New Salem Street from the south. (refer to Figure Aa-9, 10).

Wyman Gordon Site: Immediately south of the existing rail line and east of Madison Street is an existing industrial area with large parking lots in a manufacturing zone. The sites are large enough to accommodate both a commuter station and the required parking once acquired. However, grading is a problem as the rail lines are considerably higher than the level of the site. The relative isolation of the site also makes it less acceptable for commuter use. Visibility and security would be difficult to achieve for this site. The site can be accessed via Route 122A south off of route 9 or via Route 122A north off of I-290. (see Figure Aa-9, 11)

Trailways Bus Site: This site is also north of the railroad tracks and separated from them by New Salem Street. The site, located in a manufacturing zone, consists of a block of land which is bordered by Southbridge, Madison and New Salem Streets. All of the parcels on the partially vacant block, with the exception of the Trailways Bus Terminal parcel, must be acquired. Demolition of buildings on the acquired parcels, all of which front Southbridge Street, would be required to accommodate commuter parking. Grade differential at this site is a problem as the rail lines are considerably higher than the potential parking site. However, since this site would also require a structure to bridge New Salem Street, the problem of grade differential is minimized. As an alternative, access from the parking area to the station platform could be provided by installing a ramp structure starting beneath the Madison Street Bridge near the bus terminal and extending up to the platform. This alternative would negate the need to bridge New Salem Street. Route 122A, Madison Avenue, accesses the site at Southbridge Street. Route 9 also accesses the site via route 122A south (see Figure Aa-9, 12).

Millbury Street North: This site, bounded by Millbury St. and Route 122A-146, is southeast of I-290 by about five-eighths of a mile. From Route 122A-146 the site is located about a quarter of a mile south on Millbury Street. Although accommodating in size and grade, this site would require restoration of P&W spur trackage through a scrap metals reduction yard, a major development site targeted by the City of Worcester and other industrial uses. (see Figure Aa-13,14)

Millbury Street South: This site is further south of the previous site, about a mile from I-290, on Route 122A-146. This site would require restoration of the same P&W spur trackage as the Millbury St. north site, but it also is accomodating in size and grade. Again this site is accessed off Millbury Road just North of its southernmost intersection with Route 122A-146. (see figure Aa-15, 16)

Route 146/Pike Connector

This site in an area zoned for both business and industrial uses, lies between Route 20 and the Massachusetts Turnpike, just to the west of Route 146 in Millbury. The site is sufficient to accommodate 700 cars without encroaching on conflicting residential areas. Access to the site can be maximized and traffic impacts minimized by developing this site in conjunction with the Turnpike interchange for this area, which is currently in the planning stage. (refer to Figure Aa-15,17)

Milford Branch Options

Holliston

Locations for station sites are primarily in East Holliston off Route 16 (Washington Street). The sites range from rural to urban in character.

Parker Snacks: This site, zoned as an industrial district, is large enough in capacity to accommodate a new commuter rail station. Access and grading requirements are acceptable. This site is immediately accessible via Washington Avenue (Route 16), and is approximately three-quarters of a mile north of the Route 16 - Route 126 intersection. The proximity of an existing aquifer to this site, however, could create a significantly adverse environmental issue (refer to Figure Aa-18, 19).

Lowland Street: This site, south of the Parker Snacks site, is acceptable for a new commuter rail station. It is located in an industrial district but available plans designate it a residential development site. North and west of the site, the area is predominantly residential. A few industrial buildings exist within proximity of the site.

Lowland Street presents a constraint to a 730 ft. platform length and its associated needs, but full station capacity may be achieved by temporarily blocking Lowland Street while the train idles at the station. Because Lowland Street carries a low volume of traffic, blocking it may not have a significant impact. As an alternative, the full platform length could be accommodated by extending it southward along the tracks, locating it on top of a wooden trestle in the area adjacent to the stone arch bridge. All other requirements are acceptable for new station development. The Lowland site is a little more than a quarter of a mile east of Route 16 along Woodland to Lowland Street. Access to both the parking lot and the station can be made via Lowland Street. (see Figure 4-9,10).

Holliston Center: While this site was originally used as a rail station stop, it does not meet the current requirements for a commuter rail station. Its downtown location is zoned as both village center and commerical, but the major land use is residential with some scattered retail development. Additional site acquisition would be necessary to achieve proper site capacity. The additional commuter traffic in downtown Holliston could also be problematic and a full length platform would intersect two streets. This site is located a little more than a quarter of a mile east of Route 16 between Church and Center Street, just across Railroad Street. Either Church or Center Street can be used to access Railroad Street via Route 16. (refer to Figure Aa-20, 21).

Hopping Brook: This site, located in an area zoned as an industrial district, is at the entrance to the Hopping Brook Industrial Park with compatible land use and easy access off Route 16. An environmentally sensitive area exists to the west of the site which limits site area and expansion capabilities. This site is located just north of Milford. Travelling half of a mile south on Hopping Brook Road, off Route 16, directly accesses both the station and parking lot. (refer to Figure Aa-22, 23).

Milford

Routes 109 and 16, together with I-495, form a transportation triangle in southeast Milford. Sites selected as potential station locations can be found in this area. They are typically large sites easily accessed via the routes named above.

Webber's Lumber Yard: This site, bounded by Route 16 and Beaver Street, is a preferable choice. It is adequate in size and siting and compatible with the existing land use for the intended station. Located in an area zoned for industrial and commercial uses, nearby land use is primarly retail and office space. Expansion potential, however, is limited by the proximity the of existing development and major roads. Additional site acquisition will be necessary to provide for expansion. Access to this site is via Main Street (Route 16). Route 16 intersects with Route 109 approximately one-half mile southwest of the site, which in turn intersects with I-495 about three-quarters of a mile to the east. (see Figure 4-11, 12).

Sears Site: This site is a large commercial parcel located in an area designated as a highway commercial zone. It is west of Route 109, with parking serving a separate Sears Catalog Store and retail stores located in a linear building on the west end of the site. Removal of the Catalog Store located in proximity to the rail right of way provides ample parking. It is the terminus and most westerly site considered on this line. This site is south of the intersection of Routes 16 and 109, East Main and Medway Street respectively, and is accessed primarily from East Main Street. (refer to Figure Aa-24, 25).

Marlborough Branch Options

Sites chosen for the Marlborough Branch options are actually located in Framingham and Southborough. Each of the sites are located in proximity of I-495, I-90, Route 9 and Route 30.

Salem End Road: This site is in Framingham Center near Framingham State College, due south of the Salem End Road - Maynard Road intersection. It is in an R-1, single family residential district. The existing land uses are an ad-hoc mixture of industrial, institutional and residential. The site has adequate parking capacity for a new commuter rail station. Issues of contextual compatibility and site ownership (Framingham State College) are the primary concerns in locating the station. (See Figure 4-13, 14)

California Avenue: This site on California Ave. off of Route 9, is just south of the Framingham Industrial Park and northwest of a major I-90, Route 9 intersection. The site is zoned for industrial uses, and has its dominant use, large-scale warehouse development. Acquisition of several existing buildings, the Harvey and Westinghouse Industrial buildings, would be required for a new commuter rail station with parking capacity for 500 cars. This site is about a quarter of a mile west of the I-90 Route 9 intersection and can be accessed via both I-90 and Route 9. (See Figure 4-15, 16).

Southborough Center: This business district site is located at the Route 30 crossing in downtown Southborough, at the site of an old station. Commercial uses line both sides of E. Main Street. The predominant land use is residential with some retail/commercial use scattered about the site. Locating a new commuter rail station within the downtown center will require coordination with local officials, sensitivity to local concerns and plantings and screening to mitigate its impact within this area. This site is on Route 30 approximately one-quarter mile east of Route 85 - Route 30 intersection and two miles west of Route 9 - Route 30 intersection. (See Figure 4-17, 18)

Northborough Road: This site is actually located on the Marlborough, Southborough border, just west of the I-495- Northborough Road Crossing.

Approximately two-thirds of the designated site is located in a residential district, with the remaining one third in an industrial park zone. The existing site is wooded, as is the area north of the site, with the exception of an electric sub-station. Due south of the railroad tracks, the land has been designated a conservation area. Current proposals to provide off-ramp connectors from I-495 in Marlborough would substantially enhance the accessibility of this site. Consolidation of the required parking is also possible if Northborough Road is re-routed and necessary accommodations for existing power lines are made. (See figure 4-19, 20)

4.3 MOST PROMISING SITES

Worcester Line

Howe Street (Ashland)

Site Capacity:

- This long, linear site is situated in a predominantly industrial area west of the Town Center off Cordaville Road between the Sudbury River and the railroad. It can sufficiently accommodate current requirements for a new 685 parking space commuter rail station, but demolition of an existing commercially zoned building structure which formerly housed a skating rink (now owned by Olsen Medical) will be required.

Site Condition:

- The site would satisfy all grading requirements for a new platform and parking lots once demolition of the existing building structure is accomplished.
- Although it is proximate to the Sudbury River, no environmentally sensitive areas appear to be located on this site.

Community Issues/Impact:

- The general land use pattern would accommodate the introduction of the station.
- Location of the station outside of Ashland Town Center will minimize the impact of added commuter traffic.

Access:

- Cordaville Road accessed from either I-495 or I-90 is the most direct route to this site. Route 135 to Howe street would be another alternative.

Capital Costs:

- Site acquisition costs will be required and building demolition costs will also be incurred.

- Additional infrastructure and site preparation costs will be minimal due to the existing condition of development at this site.

Fruit Street (Westboro)

Site Capacity:

- The existing site, east of Fruit Street off Flanders Road is an isolated pocket with two residences and an industrial building further to the east. It is linear in form and sufficient in size to accommodate both the station platform and 1000 parking spaces.

- Additional land acquisition would be necessary to accommodate future expansion needs.

Site Condition:

- The site basically conforms to all grading needs. No grading problems appear to exist for either the platform or the required parking area.

- Although it is proximate to the Sudbury River, no environmentally sensitive areas appear to be present on this site.

Community Issues/Impact:

- Limited residential impacts will occur. One or possibly two residences must be acquired to meet capacity requirements at this location.

Access:

- Flanders Road provides direct access to the site for local traffic. Access to station parking from Route 9 is provided via Washington Street and Flanders Road. Direct access to the site from I-90 and I-495 via Fruit street is desirable, but such access would require significant modification to the interchange, (refer to Figure 4-21). If the access is provided, Fruit Street, with its currently small volume of traffic, appears capable of handling commuter traffic.

Capital Costs:

- Substantial costs will be incurred for both land acquisition and structural tasks associated with modifications to the interchange.

- Acquisition of one and possibly two private residences and an industrial building will result in additional costs.

Pine Street (Grafton)

Site Capacity:

- The site, located north of Westborough Road off Pine Street and north of the railroad, has overall capacity which is consistent with the needs of the new commuter rail service and 250 parking spaces.
- Orientation of the site with respect to the railroad line is good.
- Boundaries to the site are not restrictive, making future expansion possible.

Site Condition:

- The site, with a relative grade differential between the parking area and railroad, requires stairways to accomodate commuter access to the platform.
- Parking area is adequate and fairly well graded.
- No environmentally sensitive areas appear to exist within the proximity of the site.

Community Issues/Impact:

- Due to the mixed, but primarily residential nature of uses on Westborough Road, the potential for residential impacts does exist with the use of this site as a commuter rail station.

Access:

- Route 30 (Westborough Road), just south of the railroad station, would provide the most direct access. Routes 122 and 140 also provide access to Route 30.

Capital Costs:

- Capital costs should be minimal on this site due to limited site development land acquisition costs.

Amtrak Station (Worcester)

Site Capacity:

- Located under I-290, across from Washington Square, is an existing Municipal Parking lot which is accessed from behind a gas station and a used car dealership.

This lot is expandable to achieve the capacity required for new service.

- Sites existing to the north and south of the existing platform provide parking capacity for commuters. Reorganizing the layout would make both lots more efficient and increase the total capacity. Further expansion in the form of a parking deck over at-grade parking would be required immediately north of the platform to accommodate the required 500 spaces.

Site Condition:

- Existing grading at the Amtrak Station is adequate for use by new commuter rail service.
- The depressed grading of existing parking lots would require some form of ramp and stairway to connect to the platform level. An additional deck level would provide direct access to the platform.
- No sensitive environmental areas are present within this site. Potential problems exist where creosote ties have been dumped/stored within the site area.

Community Issues/Impact:

- New commuter rail services and the additional parking required would be consistent with current land uses on the site. No residential uses exist within immediate proximity, while existing commercial uses could benefit from the increased activity.
- All areas of the site are publicly owned and easily accessible for developing the new rail service.

Access:

- Access is convenient from I-290, Route 122 and Route 9.
- Traffic impact would appear to be minimal in light of the high use capacity of surrounding streets.

Capital Costs:

- Public ownership of the site will facilitate acquisition and minimize overall parcel cost.
- Integration of the additional traffic load and parking requirements may affect the existing infrastructure and add cost. Additional sewage, water run-off and curb cut requirements will incur costs as part of required infrastructure upgrading.

- Site development costs will be high due to the deck struture requirement for parking.

Milford Branch

Lowland Street (Holliston)

Site Capacity:

- The available site is bounded by a ten span stone arch viaduct on its southern end and Lowland Street to the north. To accommodate the full platform length, the site would require temporary stopping of traffic on Lowland Street while the train idles at the station or extending the platform on a timber trestle which is adjacent to the stone arch viaduct. Traffic impacts are evaluated in Chapter 7.
- Current siting would allow acceptable orientation to the existing railroad tracks.
- Siting parking south of Lowland Street and east of the tracks would accommodate 500 cars.
- Expansion potential is questionable. St. Mary's Cemetery and potentially sensitive environmental areas exist south and west of station site, and Lowland Street establishes a northern border with industrial areas north of Lowland Street.

Site Condition:

- Existing grading would accommodate the station and all related uses.
- Potentially sensitive environmental areas exist south of the station layout.

Community Issues/Impact:

- While the station bears no impact on surrounding residential areas, access to the site via Woodland Street may impact the surrounding areas. As Woodland Street is the primary access to Lowland Street and the industrial areas situated on Lowland Street, the presence of additional autos traveling to the station could have minimal impact on the residences that line Woodland Street.

Access:

- Route 16 (Washington Street) via Route 126, provides the primary access route. The site, however, is not directly off Route 16 and would have to be accessed via Woodland Street. Signage and directional signals would be essential for the success of a station.

Capital Costs:

- Site acquisition costs for a single parcel under private ownership will be incurred.
- Costs for a platform trestle will be incurred if traffic cannot be stopped on Lowland Street.
- Costs for addition infrastructure development would be minimal.

Webber's Lumber Yard (Milford)

Site Capacity:

- The site is constrained by the proximity of solid commercial uses along Route 16 which limit its capacity on the west end, and the Beaver Street intersection at the east end.
- The orientation of the site is parallel to both Route 16 and the existing railroad right-of-way presenting an optimal condition for station development.
- Total site capacity can accommodate approximately 225 parking spaces, which exceeds the required capacity as determined in Chapter 5, but falls short of the desired 250 spaces due to to wetlands identified on the east end of the site.
- Possibilities for future expansion are limited. Acquisitions would be required to accommodate future on grade parking. Another alternative, though costly, would involve the construction of a second level deck above the existing site.

Site Condition:

- The site as it exists is relatively flat. All grading conditions, including the parking lot, are adequate in relationship to the new commuter rail line.
- The wetlands identified on the east end of the site constrain station development in that direction.

Community Issues/Impact:

- The new commuter rail service would be located in the vicinity of a thriving commercial area on Route 16. No discernible conflict of land uses exist within the area of this development. All land parcels within the site need to be acquired for the new service. Some areas within the railroad right-of-way have been occupied by local businesses and may need to be acquired.

Access:

- The site is currently served by Route 16, and can also be accessed via Route 109. Both routes tie into I-495 just north of the site, thereby extending access and service area of this terminus station.

- The rail line will intersect Beaver Street at grade interrupting traffic flow to Route 16 and I-495.

- The siting for the new station is adjacent to an existing commercial strip. Traffic on Routes 16 and 109 would increase with commuter service, depending upon the availability of parking spaces. The impact on its overall capacity would be greatest at peak A.M. and P.M. periods.

Capital Costs:

- Site acquisition and relocation costs for viable commercial parcels will be incurred.

- Cost will be incurred for demolition of existing structures.

- Costs for infrastructure development will be minimal with the emphasis going to site preparation.

Marlborough Branch

Salem End Road (Framingham)

Site Capacity

- Acquisition of an existing Administration Building for Framingham State College is required to accommodate the new commuter rail and 750 parking spaces within a structured parking garage.

- Orientation of the railroad right-of-way is compatible with the platform position required for this site.

- The site is bounded by Salem End Road and Maynard Road to the west and north, and by residential uses to the south and east restricting future expansion possibilities. The eastern boundary includes a six foot high retaining wall.

Site Condition

- The site is relatively flat, sloping upward from west to east. All grading conditions are suitable for a new commuter rail station.

- No environmentally sensitive areas appear to exist within proximity of this site.

Community Issues:

- New commuter rail services are consistent with existing uses.
- The site is apparently under ownership of the Framingham State College and is fully utilized for parking. A joint parking development would have to be considered.

Access:

- The site is accessible via Salem End Road and Maynard Road off Route 9, which in turn is accessible via the Massachusetts Turnpike (Interstate 90).
- The residential land users along Salem End Road will be impacted by an increase in traffic flow created by commuters to the new rail station.

Capital Costs:

- Site acquisition and relocation costs will be incurred in making the site available.
- Demolition of existing structures will be required.
- The existing site remains clean and well maintained. Its current status as a parking lot meets the station requirements for grading and drainage.
- Significant costs will be incurred to build a two deck parking structure.

California Avenue (Framingham)

Site Capacity:

- The site is adequately sized for the proposed station and 500 parking spaces with the acquisition of existing industrial warehouses.
- Additional land acquisitions will be necessary to meet future expansion needs.

Site Conditions:

- The site basically conforms to all grading needs. The active rail line, however, exists six feet above the grading of the overall site and might require some adjustment (stairways/ramps) between the parking and platform levels.
- Three rail lines run east-west along the southern end of the site. One of these lines services the middle of the site, adjacent to the existing Westinghouse building, and joins the other lines in the southwest corner of the site. This siding would have to be removed with the industrial warehouses to accommodate the station.

- Environmentally, a wetland area does appear to exist within the southwest corner of the site.

Community Issues/Impacts:

- The commuter station would not adversely affect the neighboring research/development and industrial land use.
- Private landholdings appear to be available for parcel acquisitions.

Capital Costs:

- Both site acquisition and relocation costs for existing viable industrial parcels will be incurred.
- Demolition of existing structures will incur additional costs.
- Other than demolition, site preparation costs should be minimal.

Southborough Center (Southborough)

Site Capacity

- Acquisition of existing residential and commercial parcels are required to accommodate the new station and 250 parking spaces.
- Land acquisitions will be required along the sites southwestern boundary to accommodate further expansion.

Site Condition

- The existing site is predominantly level, rising in grade from Park Street to Boston Road along the northeastern edge of the site. A drainage culvert runs through the site and will have to be extended.

Community Issues/Impact:

- Neighboring commercial land uses in the downtown center would make this site appropriate for the new commuter rail. The removal of existing structures and the additional traffic flow, however, will effect the area and therefore, require full environmental consideration.

Access:

- The site is immediately accessible via Route 30 to Park Street.

- Traffic impacts would appear to be minimal given capacity of the streets within this downtown area and the forecast ridership from Chapter 5.

Capital Costs:

- Site acquisition costs will be incurred.
- Over all capital costs should be minimal due to the current site condition.

Northborough Road (Southborough)

Site Capacity

- The available site is sufficient in size and orientation for a new commuter rail station and platform.
- Accommodation of the required 1000 parking spaces requires realignment of Northborough Road and substantial site preparation within the proposed site and to the north of the realigned roadway.
- Opportunities for expansion exist to the west of the site.

Site Condition:

- Existing grading is rocky and varied. Differentials of 30 to 40 feet exist across the site which slopes down from Northborough Road to the railroad tracks.
- Potentially sensitive environmental areas exist due south of the railroad track and in the south-east corner of the site where a small brook which feeds the Assabet River is located.

Community Issues/Impact:

- Surrounding industrial land uses would not be adversely impacted by the new commuter rail station. The existing power station and its high tension wires would require special consideration because of its proximity to both the station and parking.
- Community concerns have also been raised with regard to the impact of additional traffic on Northborough Road.

Access:

- Development of an interchange and connector road via I-495 in Marlborough will provide direct access to the site via Northborough Road.

- Traffic volume along Northborough Road will increase primarily in proximity to the site and the new interchange.

Capital Costs:

- Site preparation costs including grading, drainage, roadway realignment, new infrastructure and the potential relocation of existing power poles would be substantial.

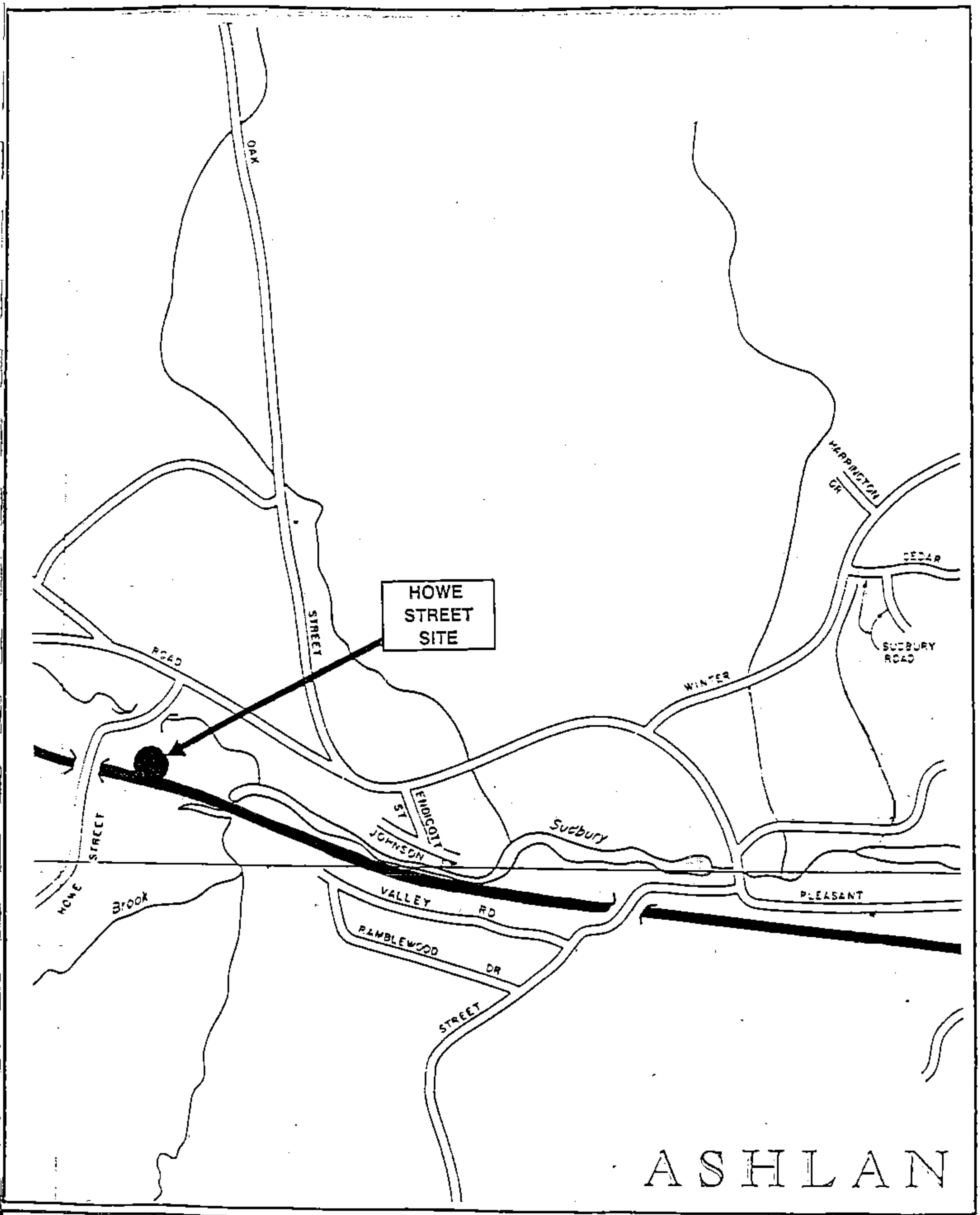
4.4 COST ESTIMATE

The Order of Magnitude cost estimate shown in Table 4-22 is broken down into four areas as follows:

- Site development includes: clearing and grubbing, grading and rolling, pavement and drainage, curbing, sidewalks, timber tie crossings, guard rails, lighting, landscaping, fencing, demolition and blasting.
- Structures and roadways includes: stairs, bridges, elevators, access ramps, retaining walls, deck parking, entry/exit ramps, open channel cover, and minor roadway modifications.
- Stations include: high and low platforms and canopies, benches and trash receptacles.
- Land costs include acquisition and relocation. It is based on informal discussions with town officials and realtors and may not represent actual costs which can only be developed through appraisals.

Unit prices were developed using previous estimates. Certain items are site specific and rough quantities were taken off in such instances. Site development for the parking lot itself was generally uniform, but in certain instances these costs were increased to recognize local conditions.

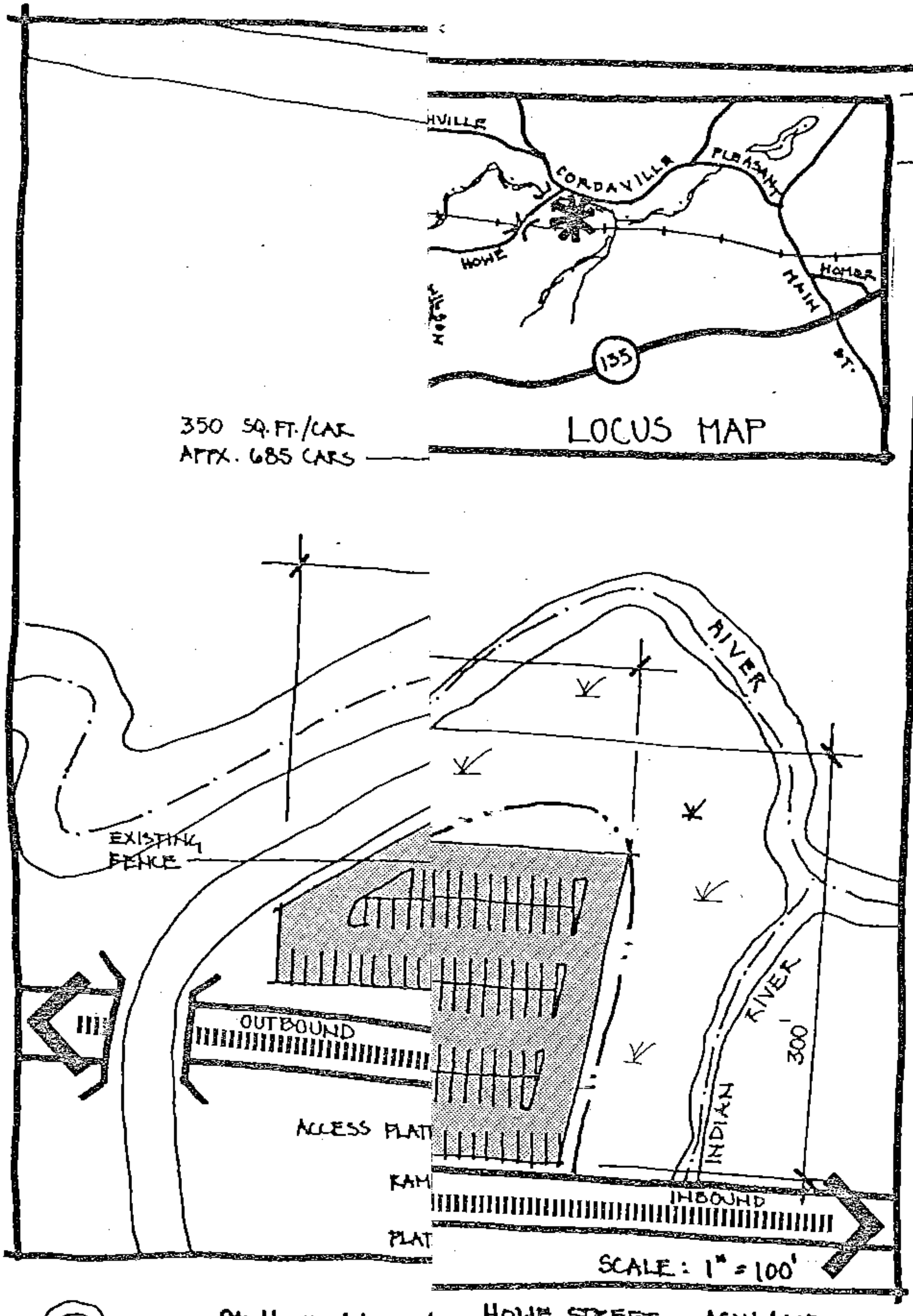
Costs are given in 1989 dollars with a final column that includes a fifteen percent contingency cost and a fifteen percent engineering cost.



MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

WORCESTER
COMMUTER RAIL EXTENSION

FIGURE 4-1



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Boston, Massa

HOWE STREET - ASHLAND

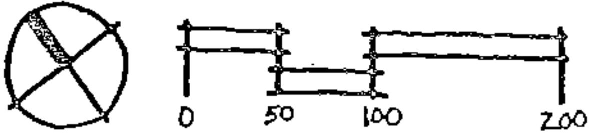
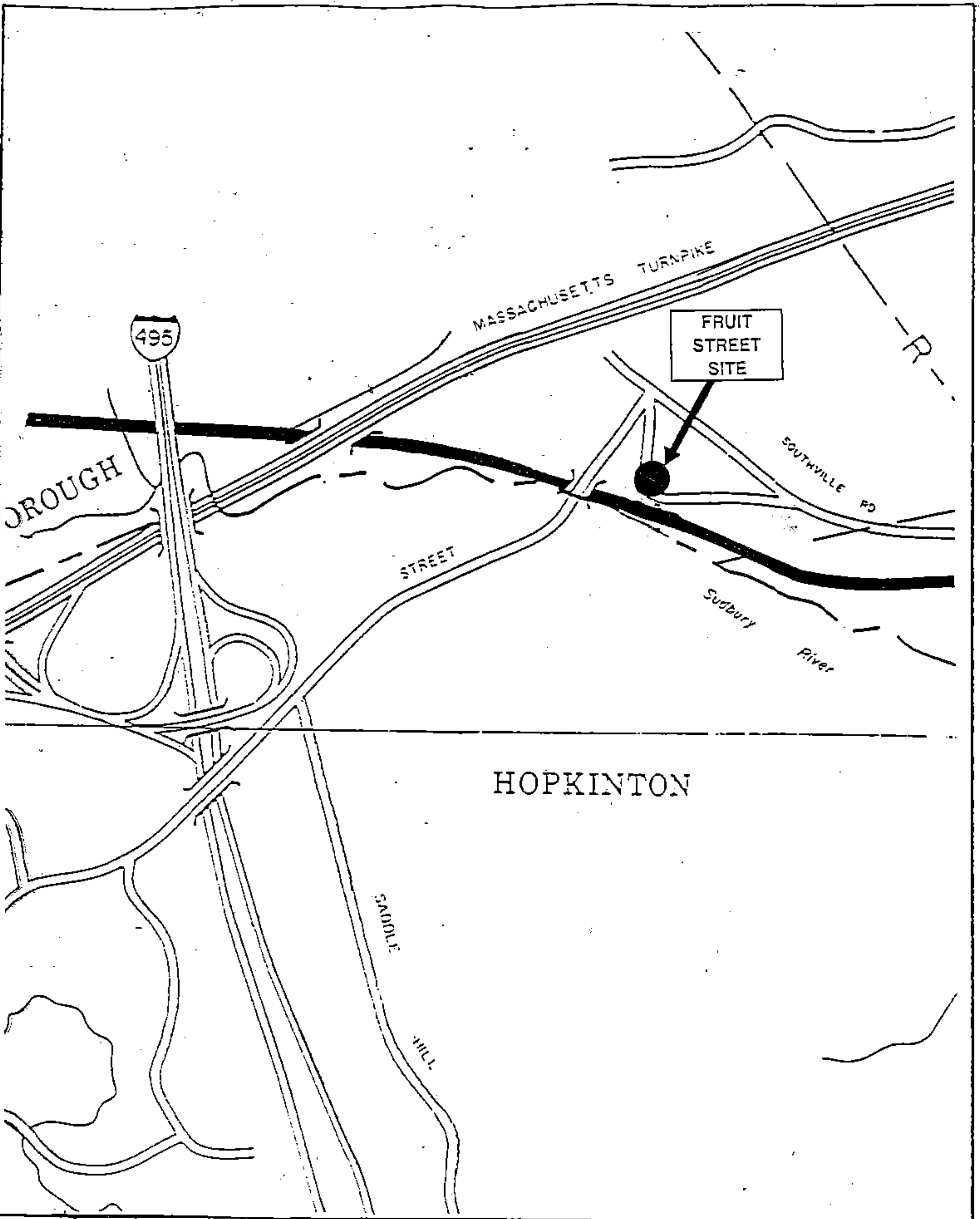


Figure 4-2



MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

WORCESTER
COMMUTER RAIL EXTENSION

FIGURE 4-3

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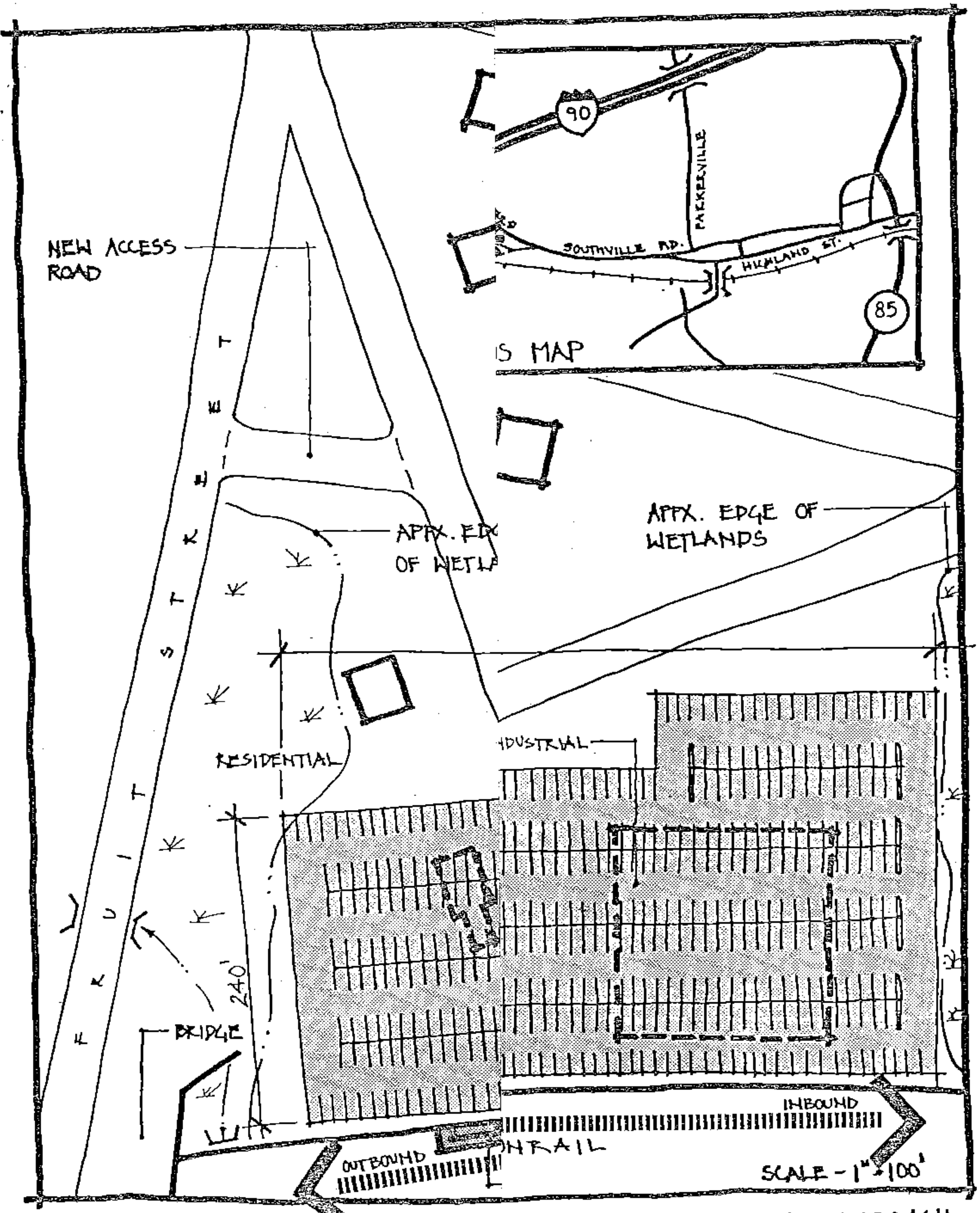

FRUIT STREET · WESTBOROUGH

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38 Chauncy Street, S
Boston, Massachuset

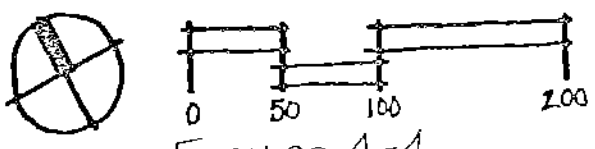
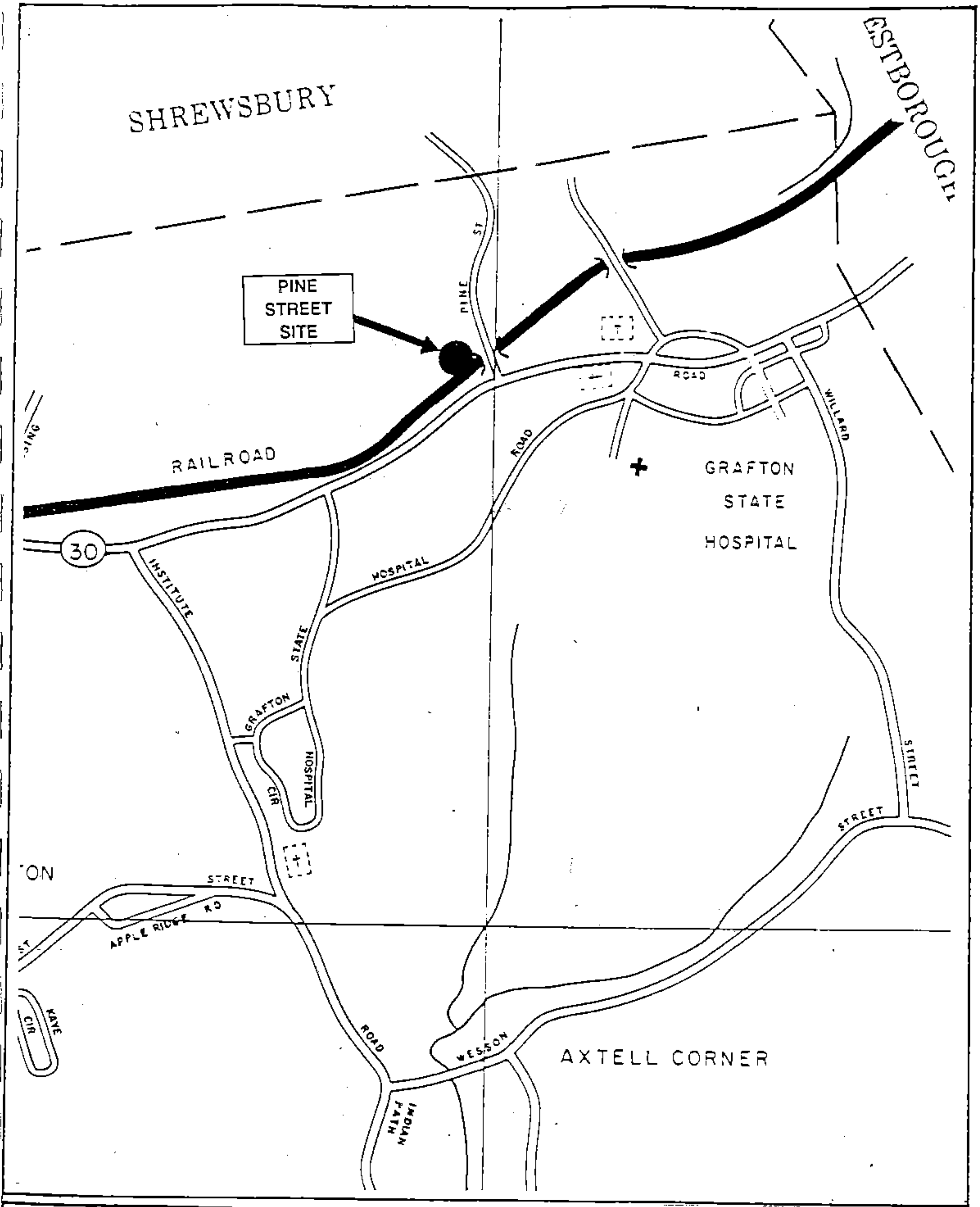


Figure 4-4

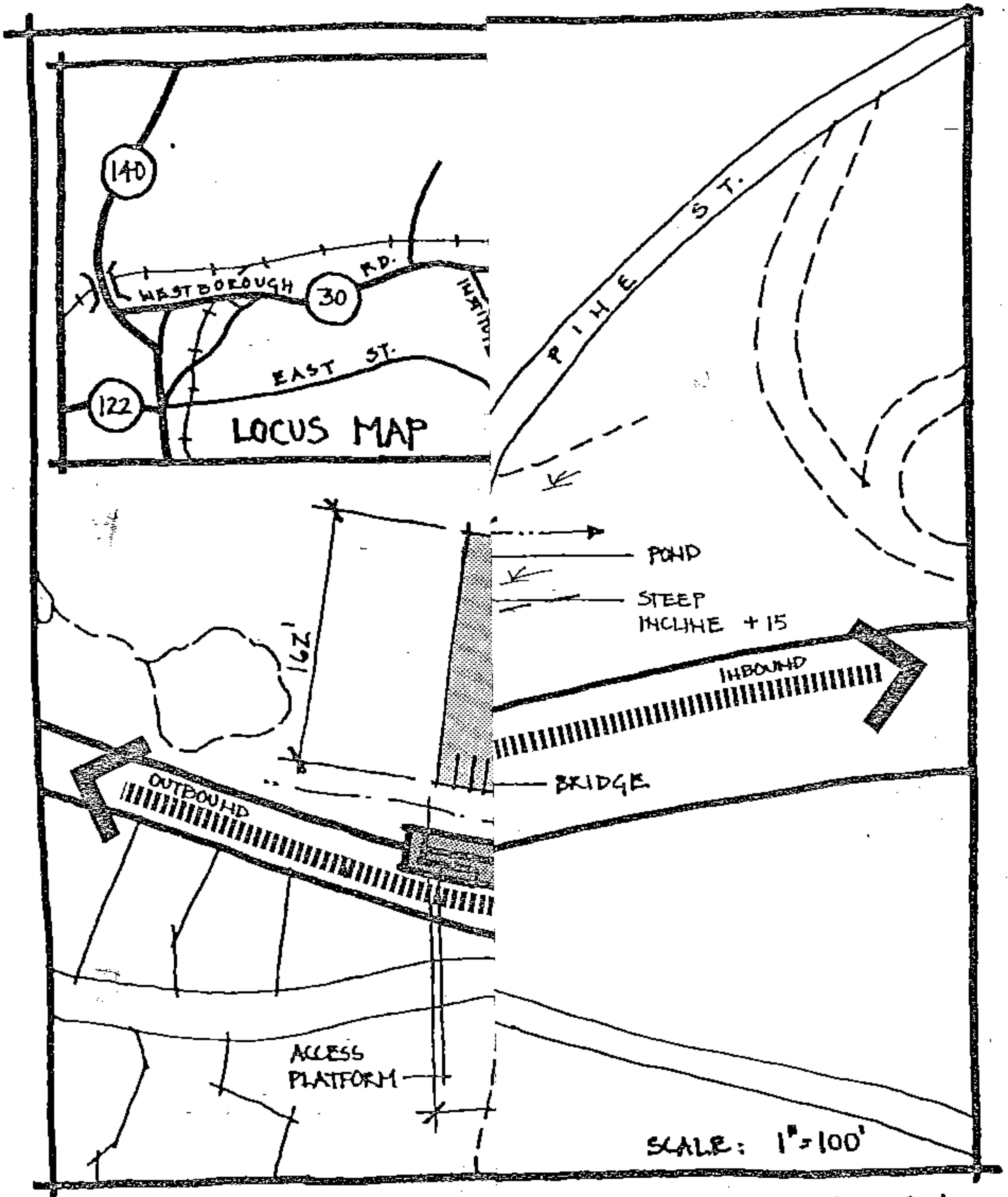


MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

WORCESTER
COMMUTER RAIL EXTENSION

FIGURE 4-5

0 1000



Stull and Lee, PINE STREET - GRAFTON
Architects an
38 Chauncy S
Boston, Massc

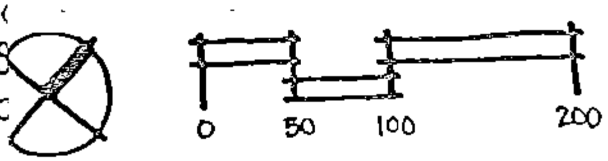
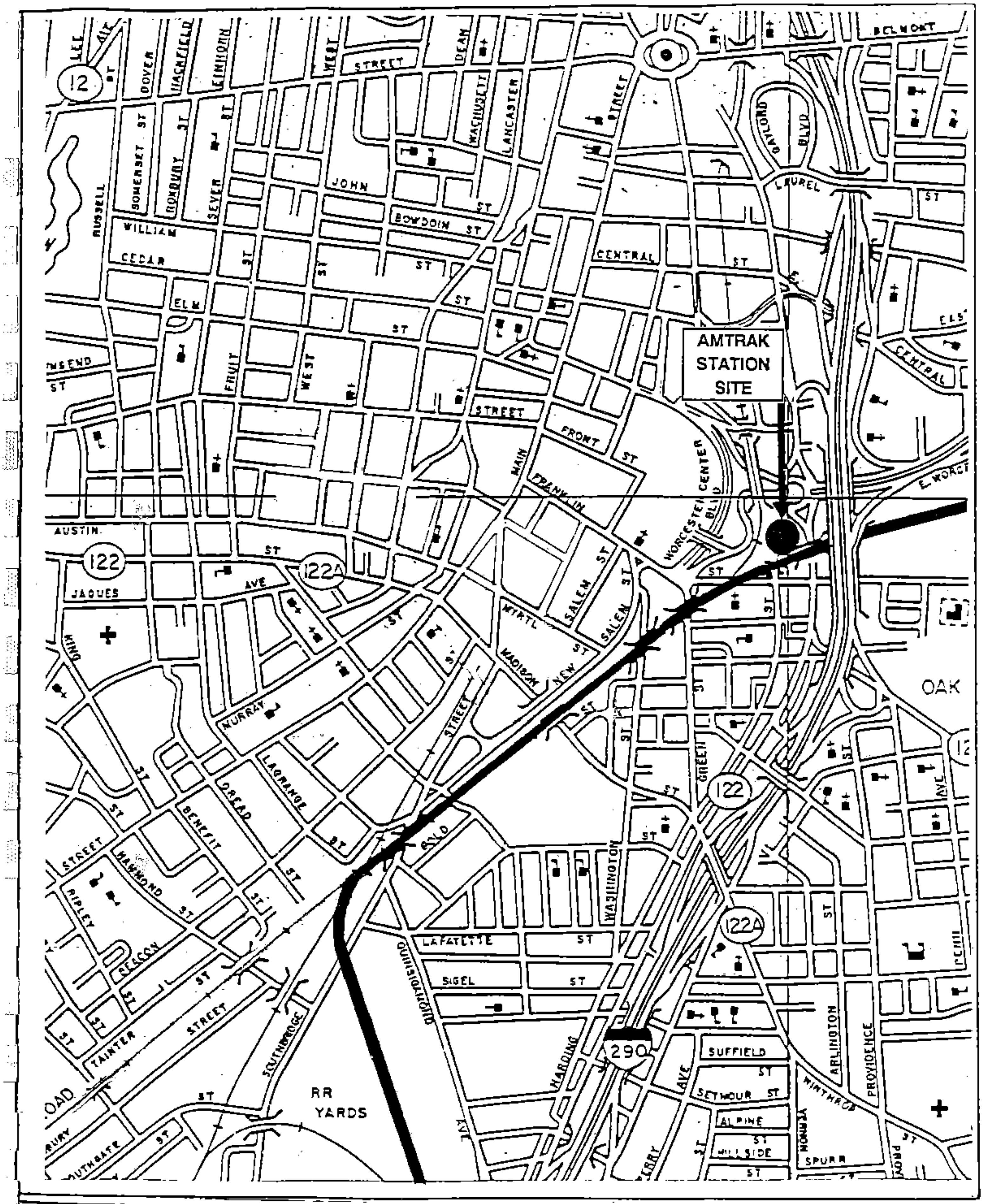


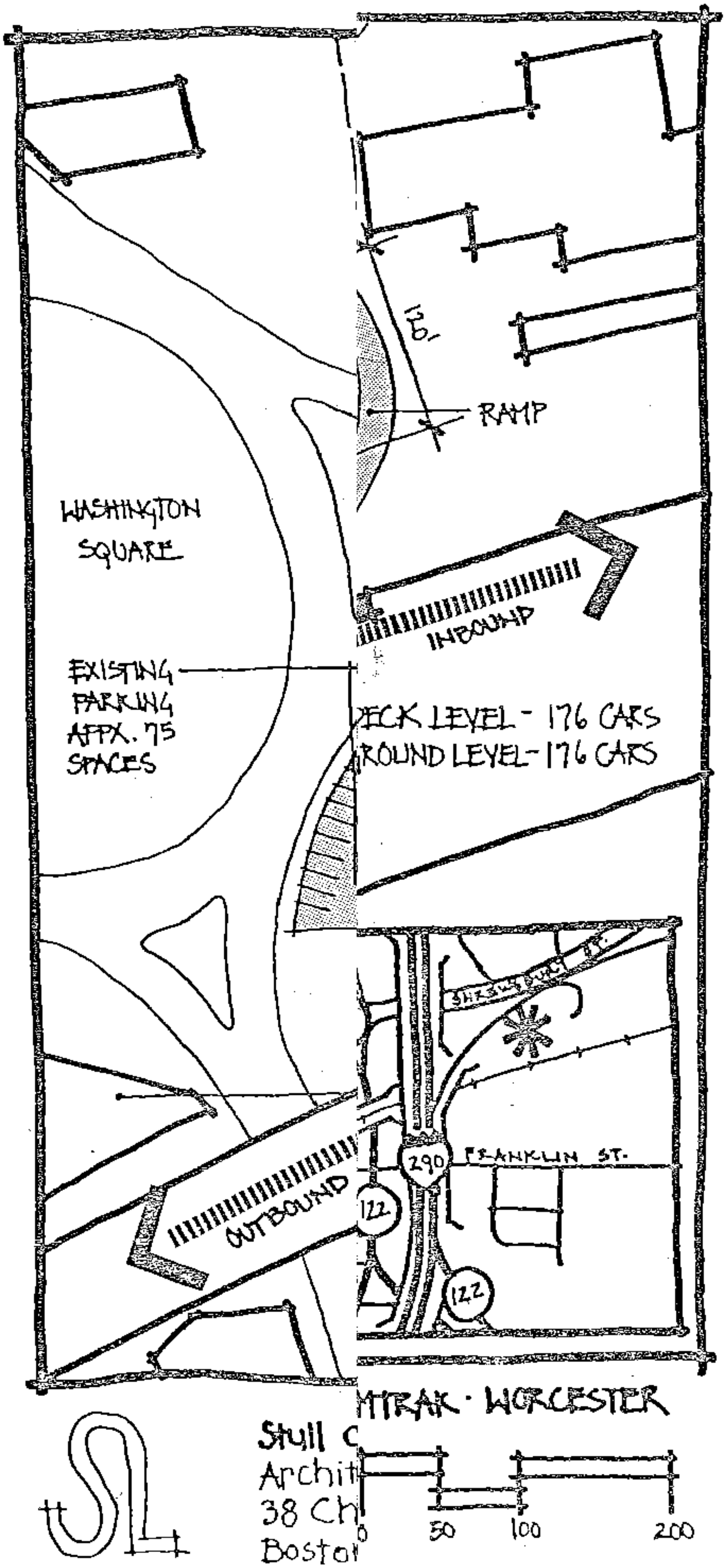
Figure 4-6



MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

WORCESTER
COMMUTER RAIL EXTENSION

FIGURE 4-7


120'
RAMP
WASHINGTON SQUARE
INBOUND
EXISTING PARKING APPX. 75 SPACES
ECK LEVEL - 176 CARS
ROUND LEVEL - 176 CARS
SHREWSBURY ST.
FRANKLIN ST.
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122
OUTBOUND
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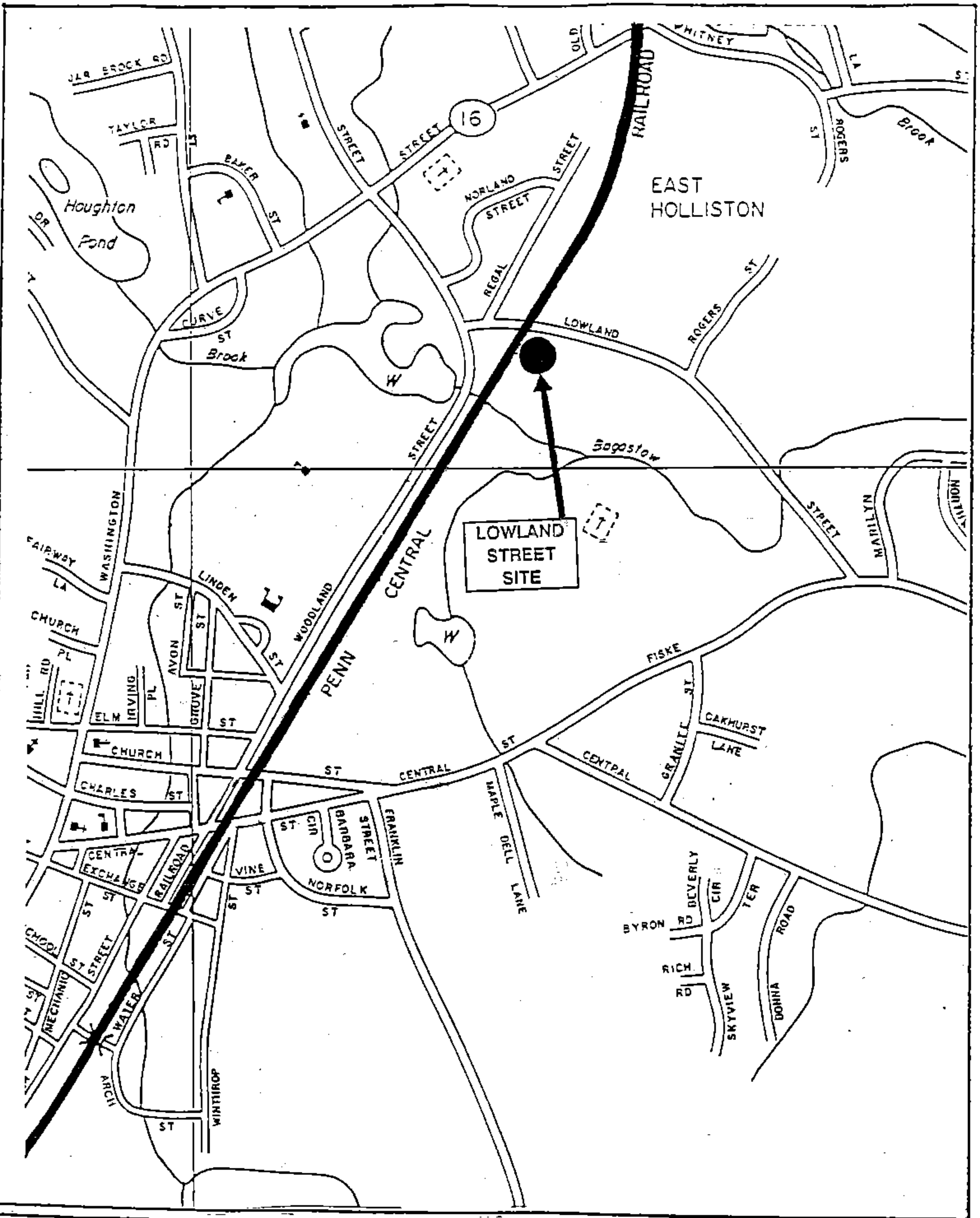
Figure 4-8



MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

MILFORD
COMMUTER RAIL EXTENSION

FIGURE 4-9

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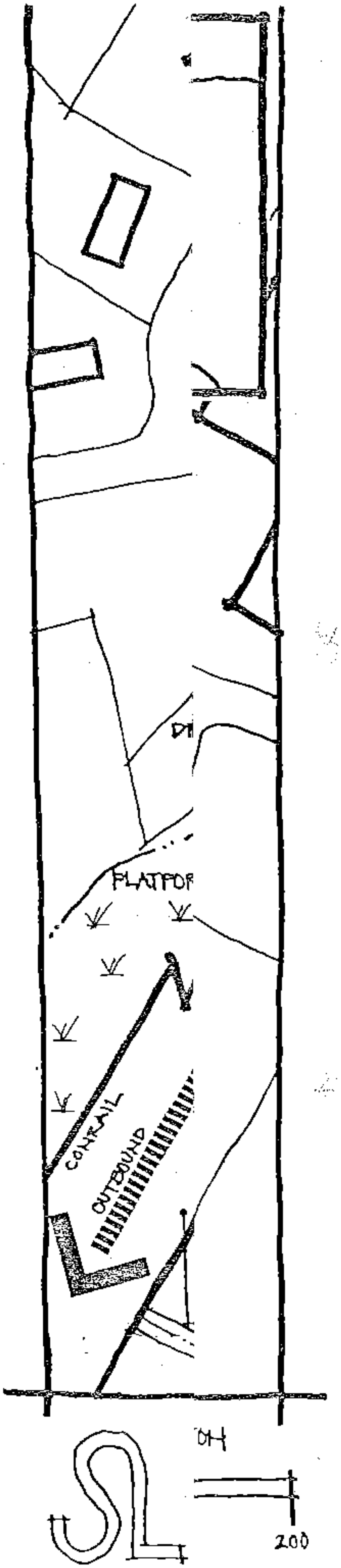
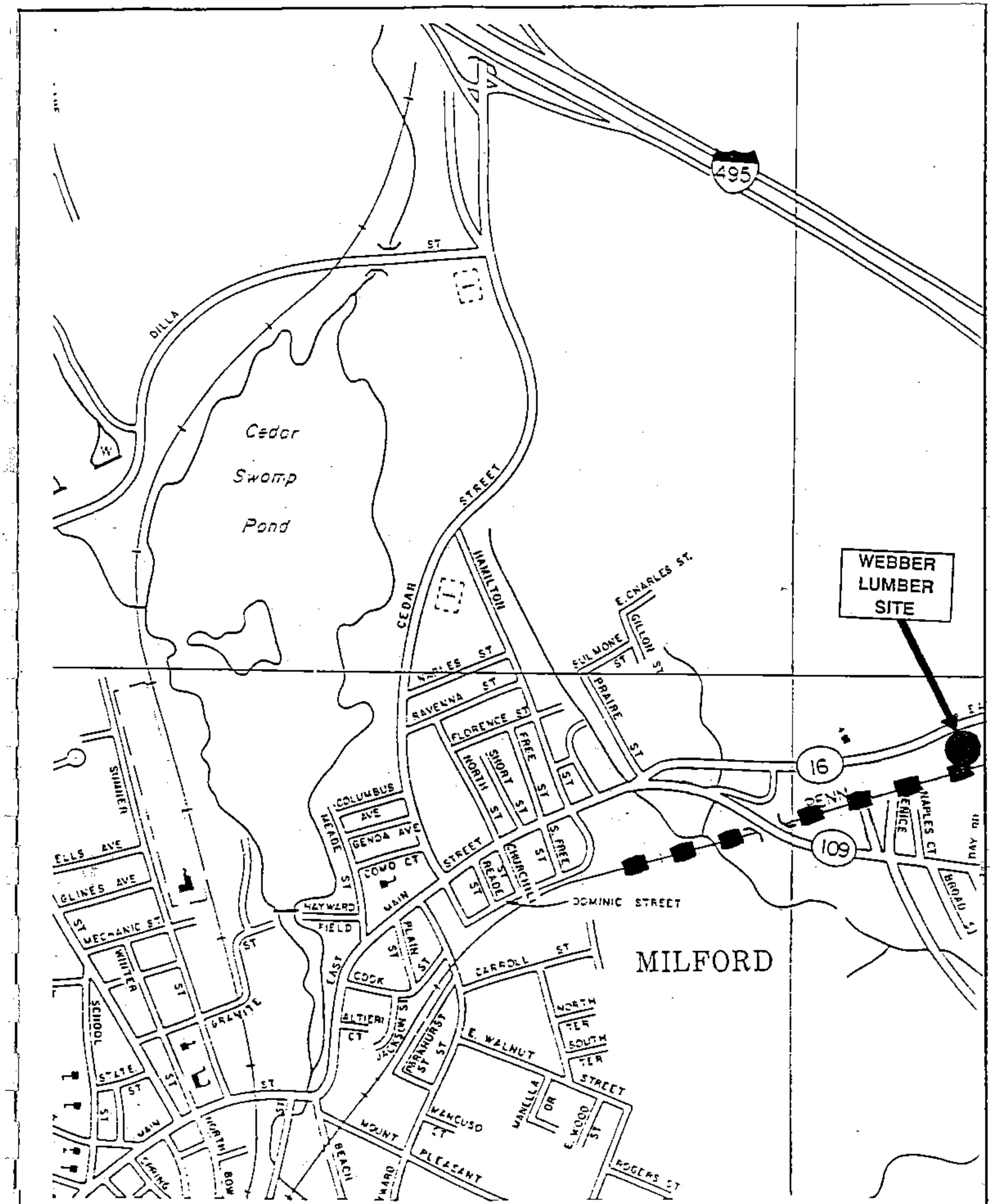


Figure 4-10



MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

MILFORD
COMMUTER RAIL EXTENSION

FIGURE 4-11

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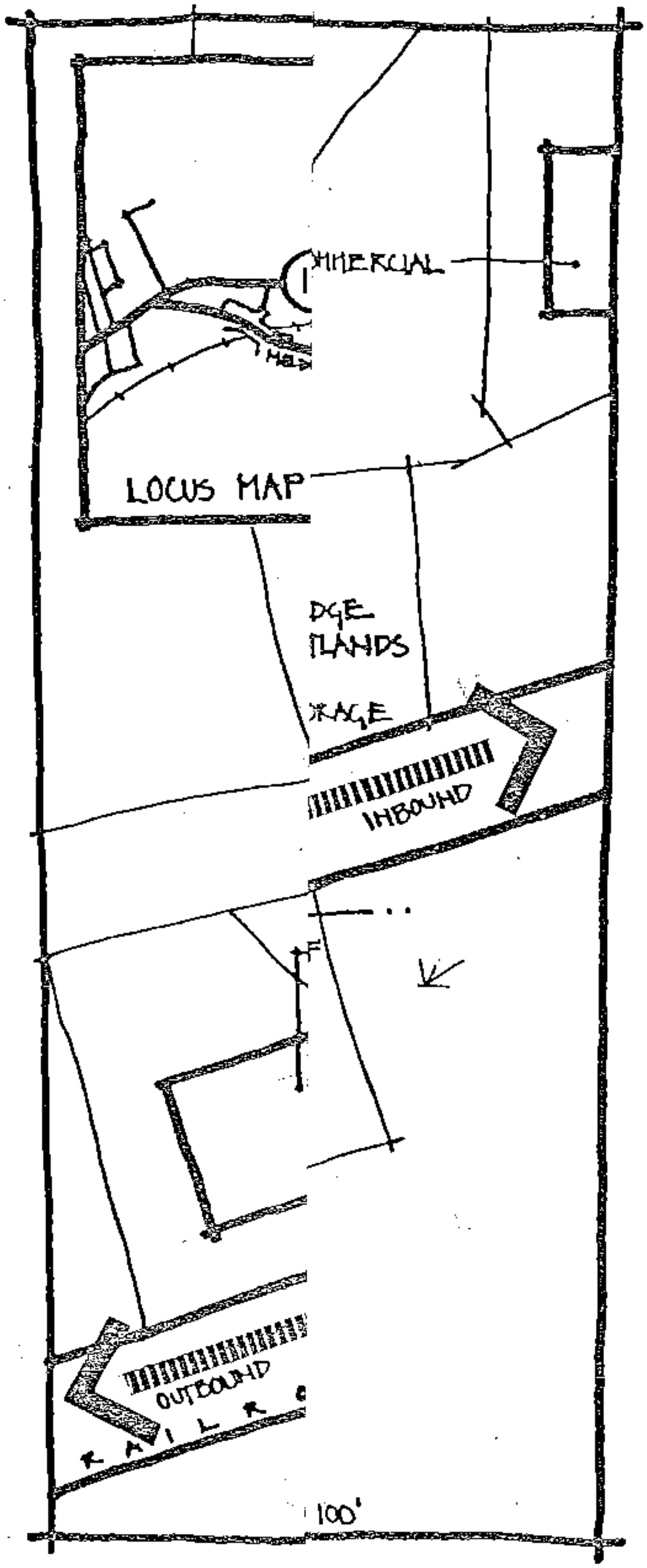
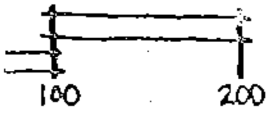
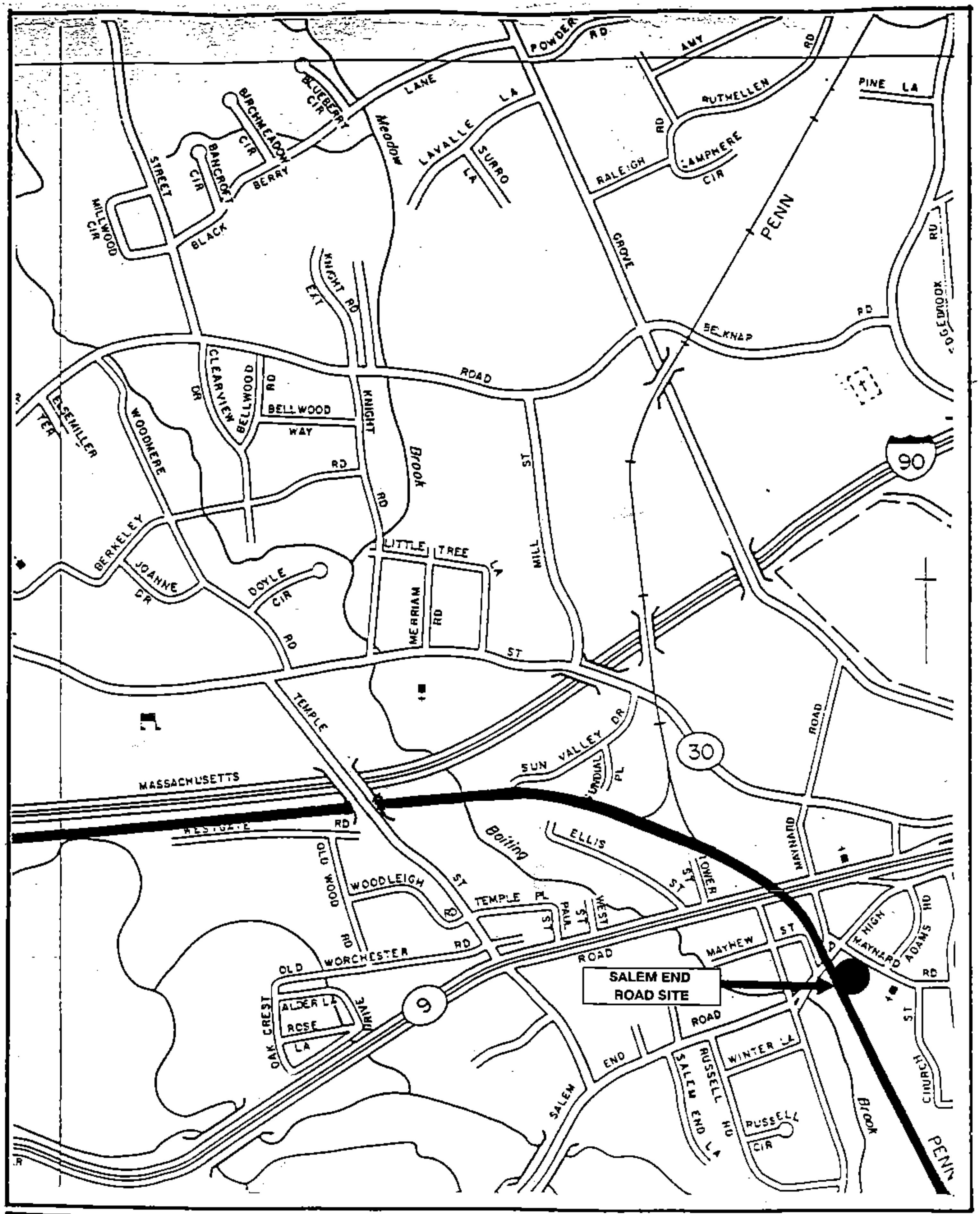


FD - MILFORD



ure 4-12



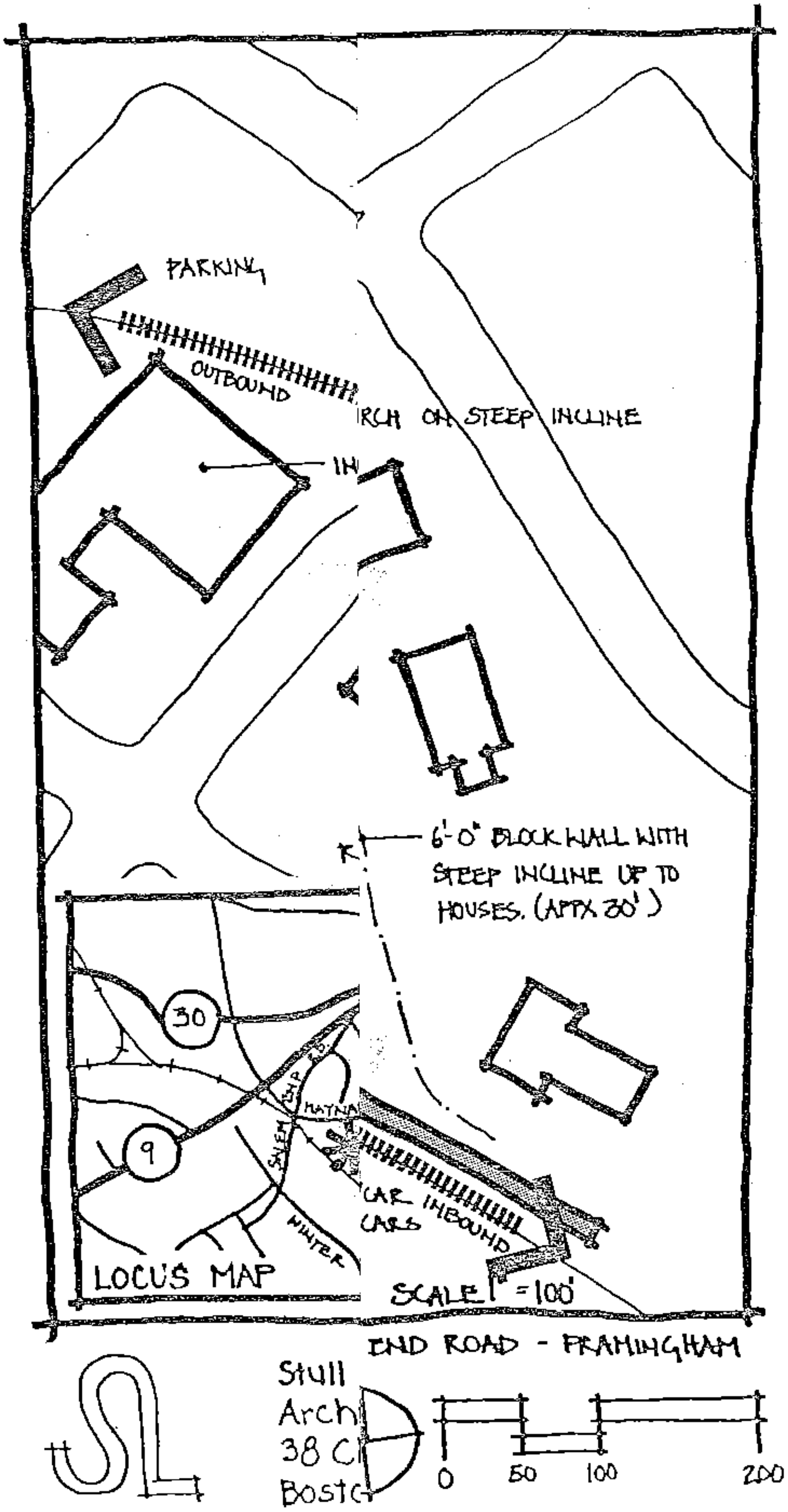
SALEM END ROAD SITE

MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

MARLBOROUGH
COMMUTER RAIL EXTENSION

FIGURE 4-13

0 1000


PARKING
OUTBOUND
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IN
6'-0" BLOCK WALL WITH
STEEP INCLINE UP TO
HOUSES. (APPX 30')
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9
SHP RD
MAYNA
SALEM
WINTER
CAR INBOUND
CARS
LOCUS MAP
SCALE 1" = 100'
END ROAD - FRAMINGHAM
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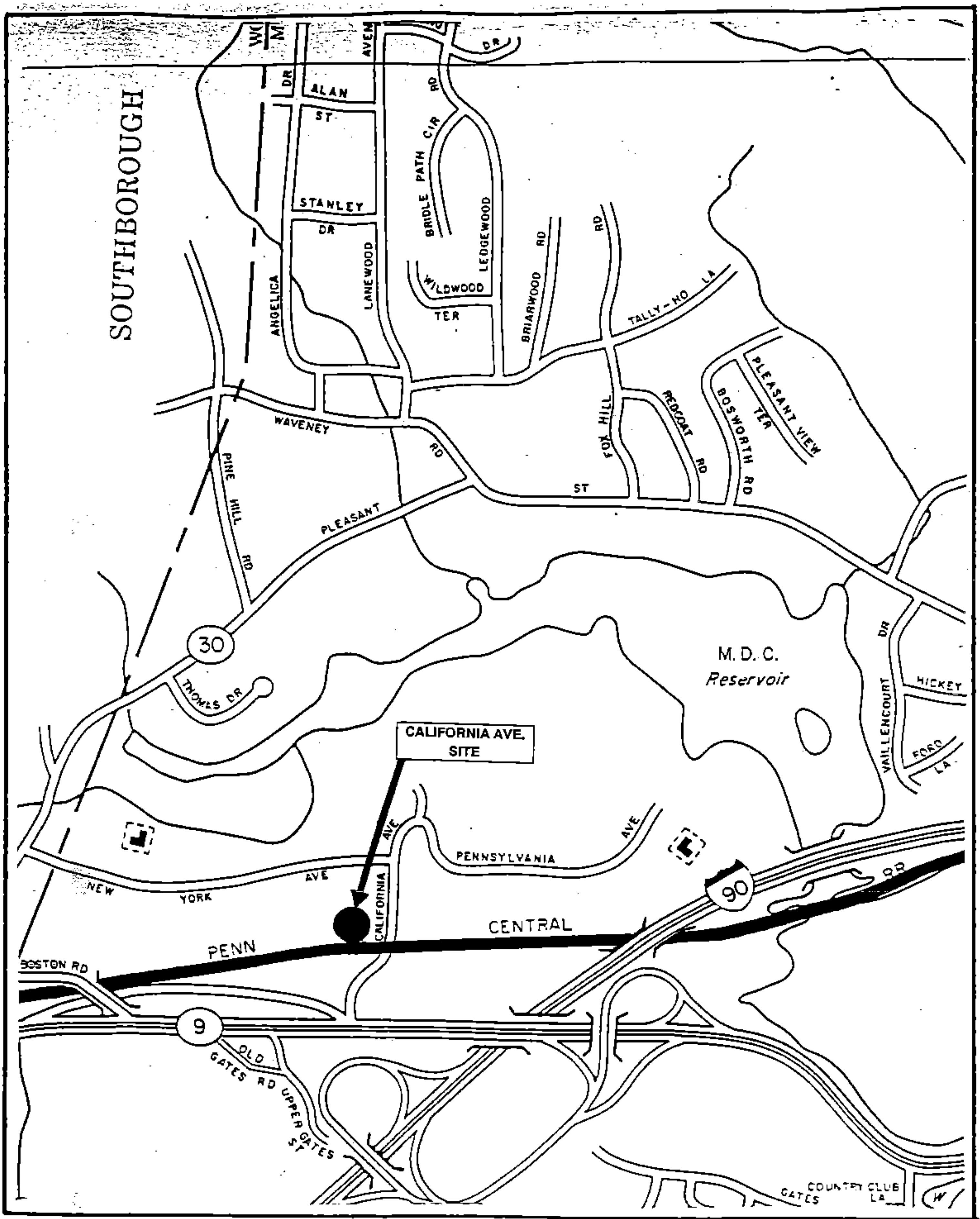
Figure 4-14



MASSACHUSETTS
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MARLBOROUGH COMMUTER RAIL EXTENSION

FIGURE 4-15

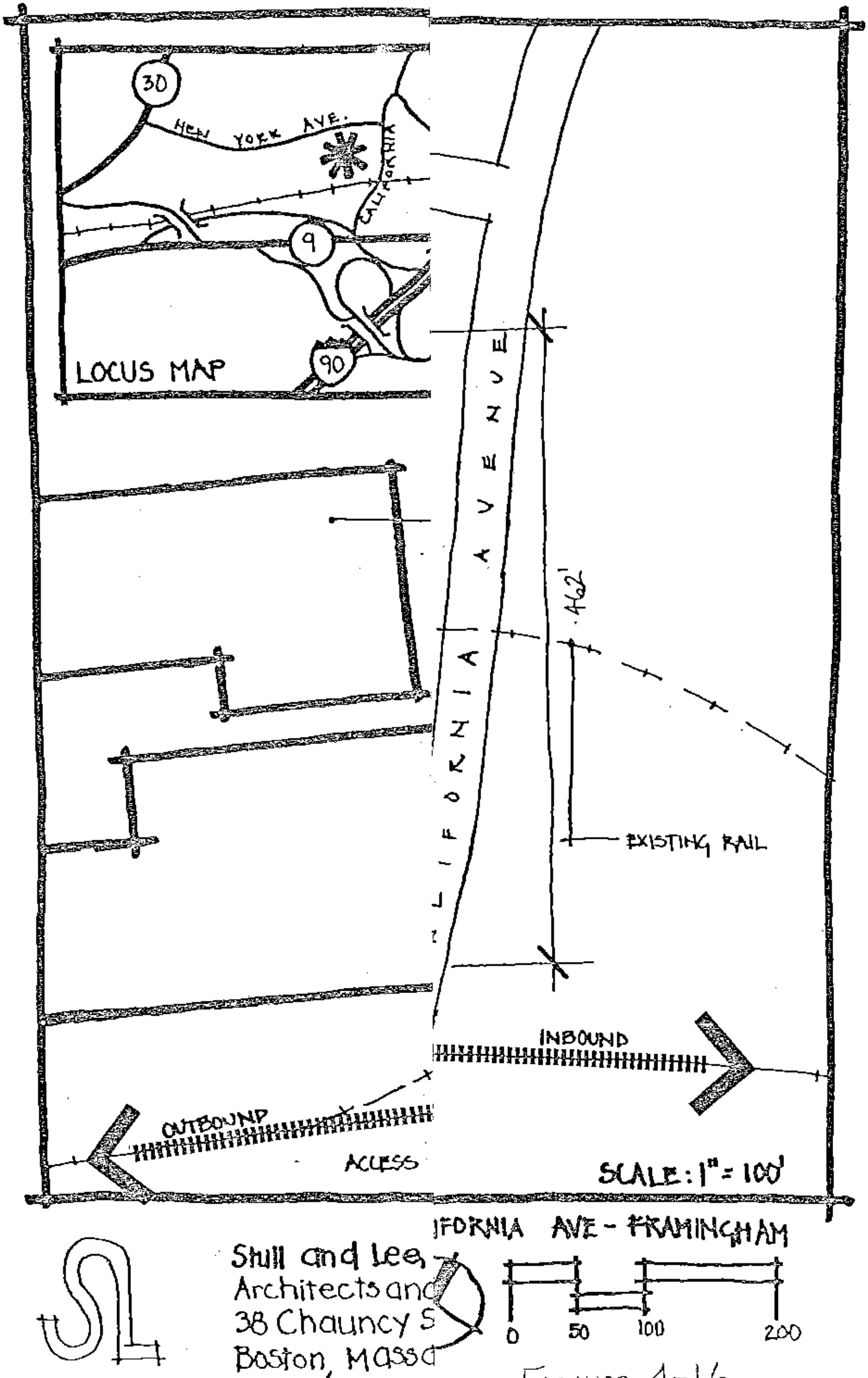
LOCUS MAP
30
NEW YORK AVE.
CALIFORNIA
9
90
LIFORNIA AVENUE
462'
EXISTING RAIL
INBOUND
OUTBOUND
ACCESS
SCALE: 1" = 100'
IFORNIA AVE - FRAMINGHAM
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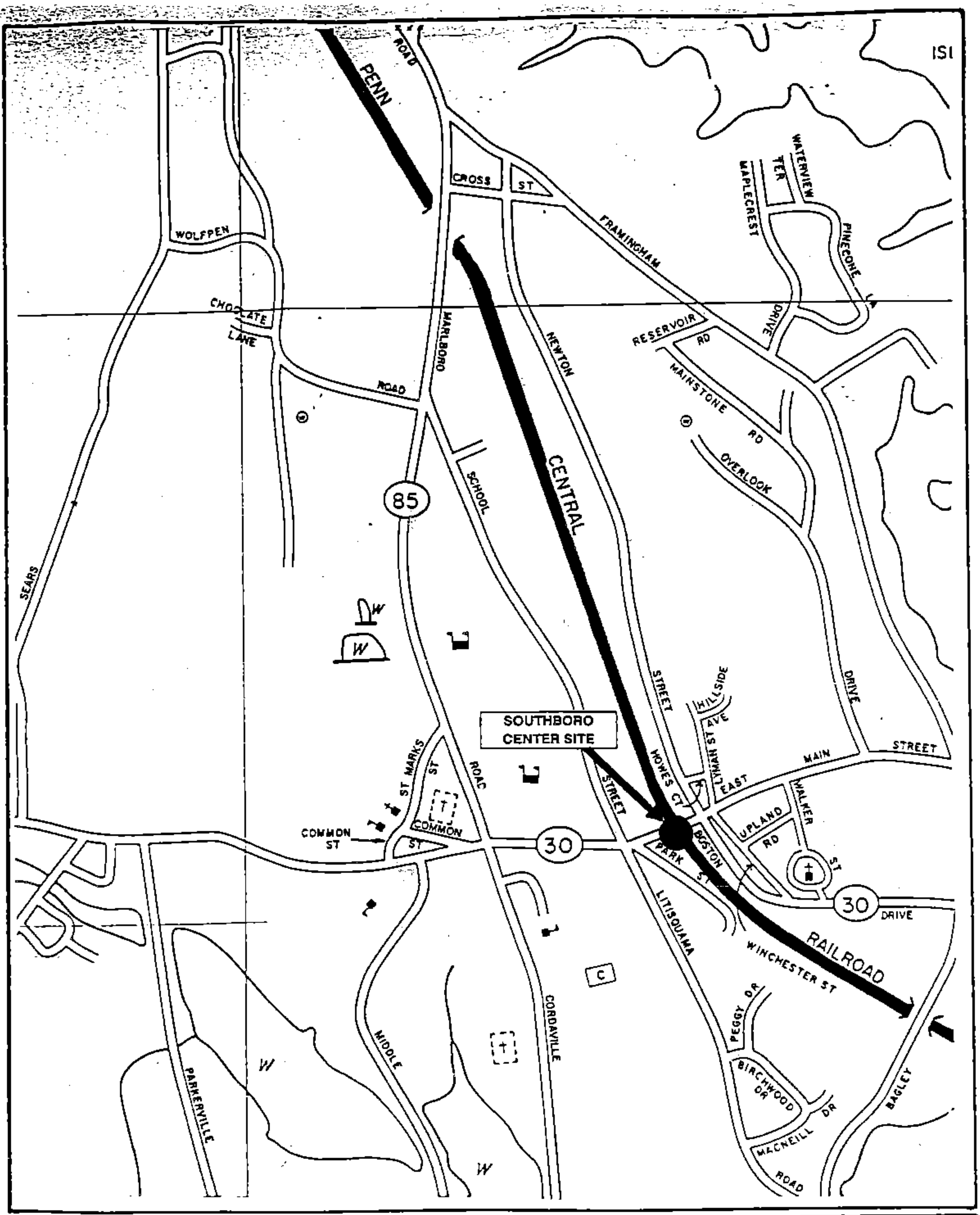
Figure 4-16



MASSACHUSETTS
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MARLBOROUGH
COMMUTER RAIL EXTENSION

FIGURE 4-17

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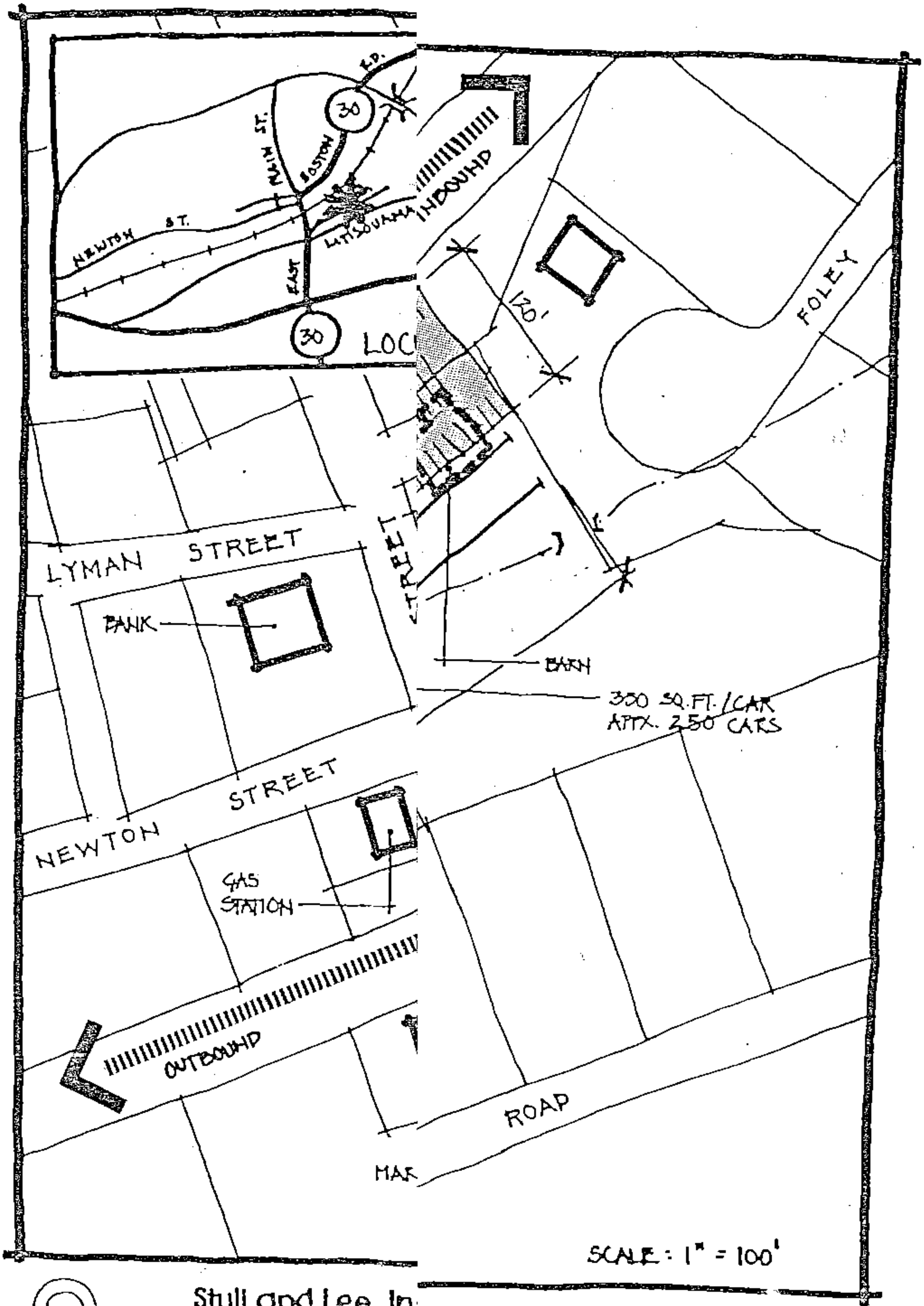

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Boston, Massach

OUTHBOROUGH CENTER · SOUTHBOROUGH

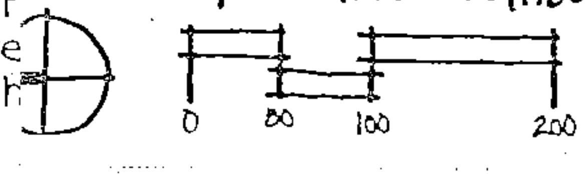
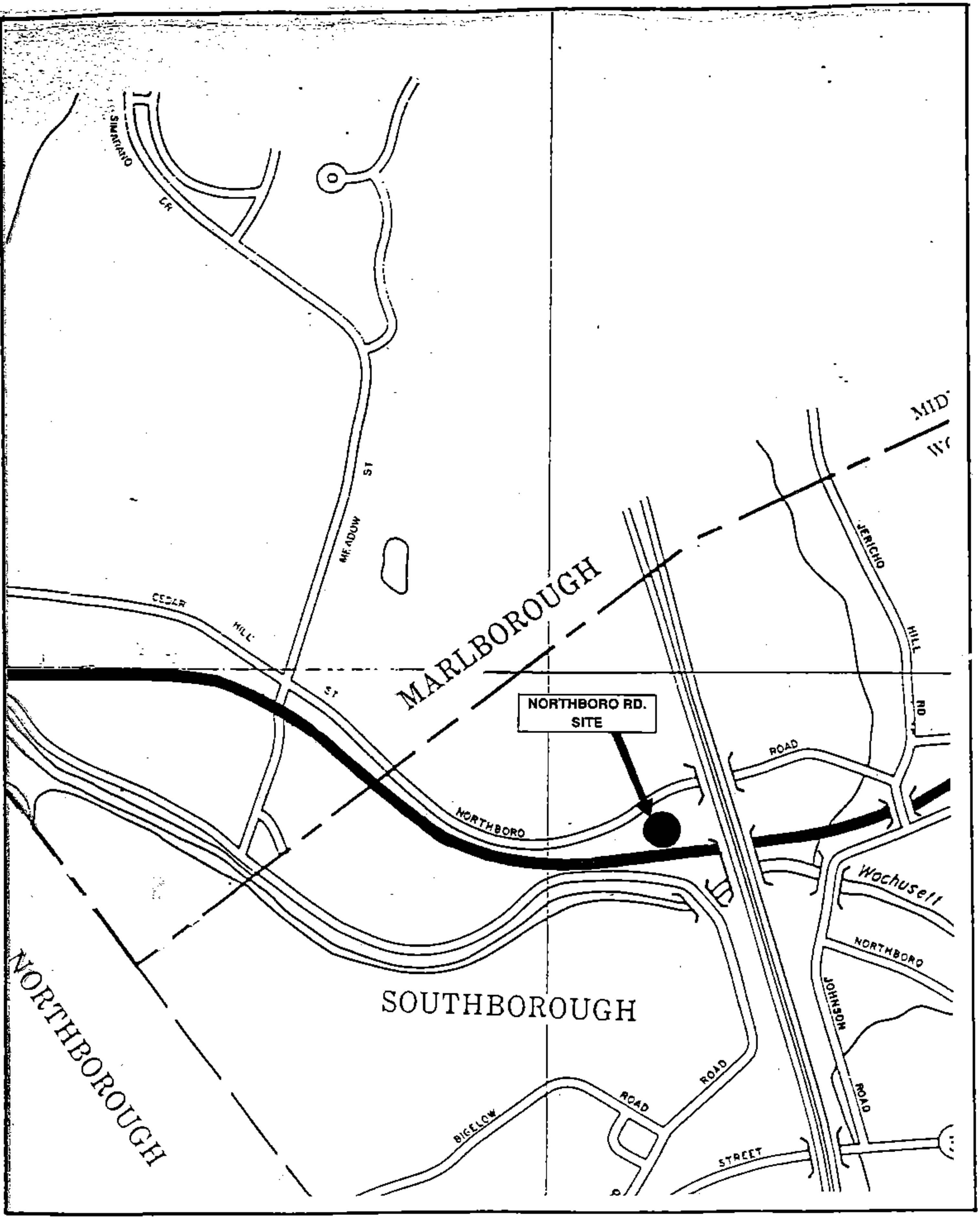


Figure 4-18



NORTHBORO RD. SITE

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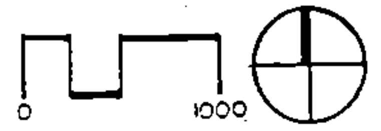
MARLBOROUGH
COMMUTER RAIL EXTENSION

FIGURE 4-19



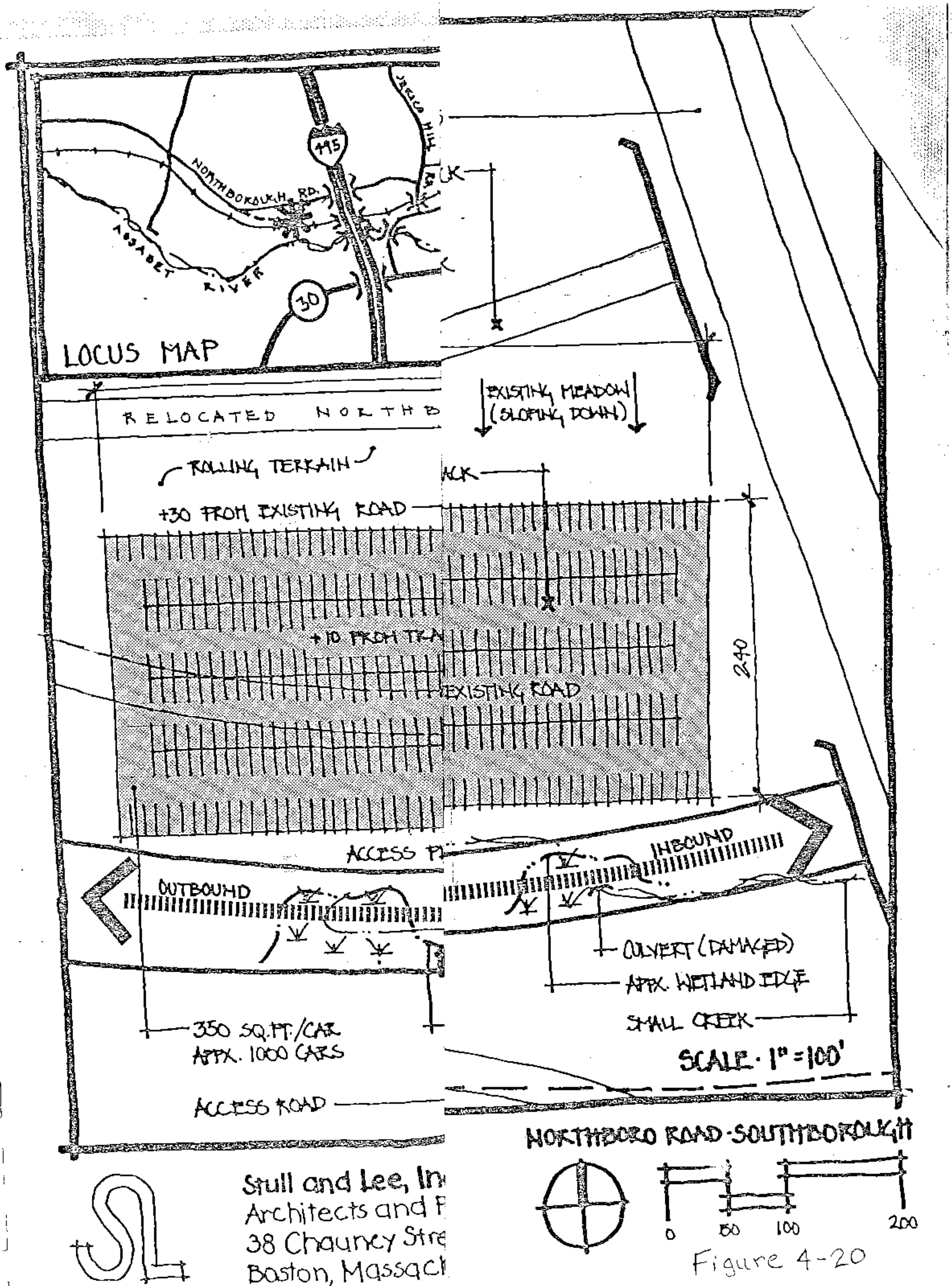


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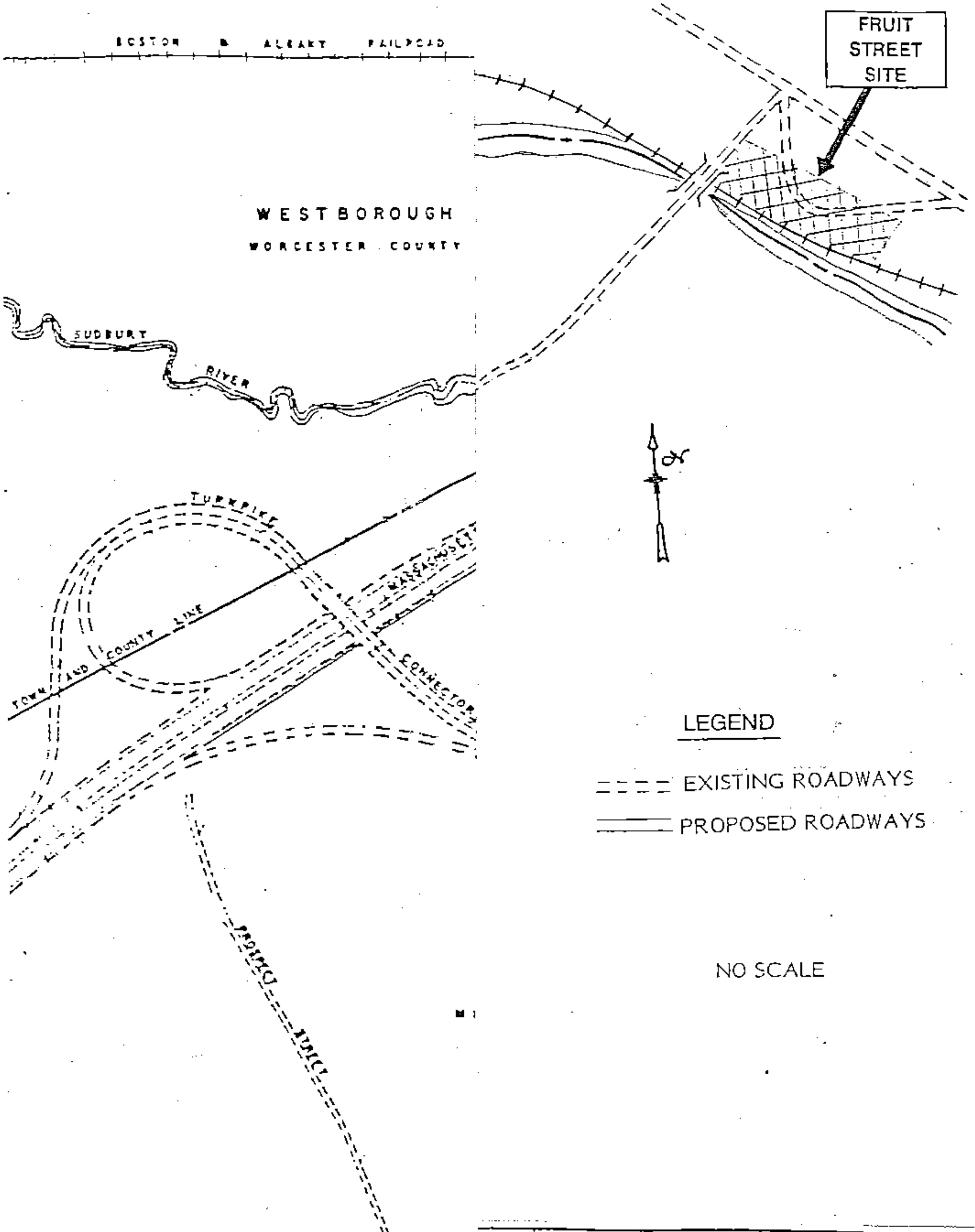
Figure 4-20



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WORCESTER

COMMUTER RAIL EXTENSION

FIGURE 4-21

TABLE 4-22
ESTIMATED STATION COSTS

STATION SITES	No. of CARS	AQUIRED ACRES	LAND AQUISITION & RELOCATION COSTS	SITE DEVELOP. COSTS	STATION COSTS	STRUCTURE & ROADWAY COSTS	TOTAL CONST. COST (w/o Land Aquis. or Relocation)	TOTAL COST (w/ Land Aquis. and Relocation) (a)
WORCESTER LINE								
Ashland Center	250	1.3	260,000	496,072	165,812	0	661,884	1,135,342
Cherry St.	250	2	300,000	453,572	165,812	0	619,384	1,119,135
* Howe St.	685	5.5	2,425,000	1,354,961	165,812	200,000	1,720,773	4,700,722
Route 85	250	2	540,000	662,472	165,812	103,000	931,284	1,771,623
* Fruit St.	1,000	8	3,018,000	1,888,489	165,812	6,048,786	8,103,087	13,734,333
* Pine St.	250	2	300,000	524,872	165,812	245,700	936,384	1,538,368
Parmeter Crossing	250	2	240,000	445,472	165,812	225,000	836,284	1,345,986
Milepost 38.75	250	2	373,320	518,672	165,812	0	684,484	1,278,550
* Amtrak Station	500	4.1	820,000	539,711	78,600	2,258,560	2,876,871	4,624,662
Salem Mun. Park. Lot	500	1.6	160,000	70,000	165,812	5,450,000	5,685,812	7,679,486
Wyman Gordon	500	4	2,050,000	915,500	165,812	300,000	1,381,312	3,876,785
Trailways Bus Terminal	500	1.6	3,436,000	144,400	165,812	5,425,000	5,735,212	11,020,818
Milbury St. North	500	4	932,000	897,544	165,812	0	1,063,356	2,338,288
Milbury St. South	500	4	800,000	881,044	165,812	0	1,046,856	2,184,467
Route 146 / Mass Pike Connection	670	5.4	540,000	1,313,866	165,812	595,000	2,074,678	3,283.762
LINE TOTAL *							$13,637,115	$24,598,085
MILFORD BRANCH								
Paker Snacks	110	0.9	675,000	256,738	165,812	0	422,550	1,233.822
* Lowland St.	500	4	600,000	871,444	165,812	0	1,037,256	1,971.771
Holliston Center	120	1	200,000	126,325	165,812	300,000	592,137	983,101
Hopping Brook	350	2.8	280,000	619,811	165,812	0	785,623	1,318.986
* Webber's Lumber Yard	250	2	1,316,000	528,052	165,812	0	693,864	2,233,635
Sears	250	2	884,000	452,522	165,812	1,946,000	2,564,334	4,275.332
LINE TOTAL *							$1,731,120	$4,205,406
MARLBOROUGH BRANCH								
* Salem End Road	750	2	200,000	70,000	165,812	7,500,000	7,735,812	10,430.611
* California Avenue	500	4	4,992,000	1,069,944	165,812	0	1,235,756	6,626.287
* Southborough Center	250	2	545,000	440,472	165,812	93,150	699,434	1,470.001
* Northborough Road	1,000	8	1,200,000	1,859,489	165,812	310,500	2,335,801	4.289,097
LINE TOTAL *							$12,006,803	$22,815,997

* CONSIDERED MOST DESIRABLE SITE (LINE TOTALS FOR MOST DESIRABLE SITES)

(a) INCLUDES 15% ENGINEERING AND 15% CONTINGENCY ON CONSTRUCTION COSTS

CHAPTER 5

RIDERSHIP FORECASTS

This chapter describes the development of ridership forecasts for each of the alternatives in the target year 2010. The chapter is divided into four sections. Section 5.1 discusses the potential market groups for commuter rail. Section 5.2 defines market factors and market area boundaries. Section 5.3 discusses the forecasting approach. Section 5.4 presents the results of the ridership forecasting analysis.

5.1 POTENTIAL COMMUTER RAIL MARKET GROUPS

Commuter rail service in the Worcester, Marlborough and Milford corridors is aimed at the work trip traveller who resides in the western suburban towns and commutes into central Boston on a daily basis. This market group presents the greatest need for and greatest propensity to use rail service. Supporting this view are the following:

- Worktrip commuting occurs primarily in the peak periods when traffic congestion presents the most significant deterrent to automobile travel.

- Worktrip commuters are most negatively impacted by the restrictive parking conditions in central Boston. This is somewhat by design, in that Boston is trying to allocate more of its limited parking resources to more intense, auto-dependent retail activity which has shorter duration demands.

- Worktrip commuters are more disposed to public transportation due to centralized destinations, highly peaked travel patterns, repetitive tripmaking and, in some cases, employer subsidy of travel cost by public transportation.

As a result, it is on this market group that the ridership analysis focuses. In fact, the entire ridership forecasting methodology is based on the travel behavior associated with work trip commuting in peak period conditions. The approach is more fully described in Section 5.3. Despite the focus on the worktrip commuter as the critical need and justification for commuter rail, other market groups are not ignored. These additional market groups are described briefly below.

Reverse Commute Worktrips

The development of a rail service connection between urban centers like Worcester and western suburbs with significant commercial and business centers potentially provides an opportunity to serve reverse commute trips, that is, trips by residents of central Boston (or adjacent residential areas) to more remote suburban employment centers. There are several factors which hinder this ridership potential while other factors encourage it.

Central Boston residents may be more likely to use commuter rail due to their lower rates of automobile ownership and greater propensity to use public transportation. Lower auto ownership groups in the central city tend to fall into one of two groups. The first is the lower income person who finds the costs of automobile ownership prohibitive or less attractive than utilization of public transportation. If the employment centers were likely to attract lower income and less skilled workers, reverse commuter ridership by this market could develop provided the service operates at the appropriate times and provides convenient access to the employment centers. If the jobs offered at suburban employment centers are higher skilled positions at higher wages, the availability of the service to the lower income market may be irrelevant.

The other group that exhibits low auto ownership is the more affluent urban resident who lives and works in the center city core, walking, using taxis and public transportation for intraurban travel. Trips by this group would not be likely to be attracted to commuter rail service, since a change in work trip location would likely influence auto ownership decisions.

Even among the likely reverse commuters, mode choice would be impacted substantially by convenience issues. If the rail stations are not located immediately adjacent to employment centers or served by shuttle or high frequency bus service, reverse ridership is unlikely to develop. While park and ride is an effective access mode and is likely to be a primary consideration in station location, walk or transit egress is a prerequisite for reverse commuting. Another issue is the convenience of the schedule. Early morning trains leaving the western terminus of the extension rail service heading into Boston will not return to the terminus for some two hours. It would be difficult to provide access to suburban jobs during industrial shift hours or even typical office hours on return trips.

Very little reverse commuting now takes place on the existing MBTA Commuter Rail system. It is, however, useful to look at rail service to Providence on the Attleborough Line, which is somewhat analogous to the proposed rail service to Worcester. Providence is a medium-size city with a dense downtown located about one hour away from Boston by automobile, as is Worcester. While Providence is smaller than Worcester, its employment is somewhat more concentrated downtown in the vicinity of the rail station than that in Worcester. Currently, only one train serves Providence from Boston in the morning peak period and there is only one return train to Boston from Providence during the evening peak period. The March, 1989 MBTA audit shows that 48 passengers boarded the evening train in Providence. None of them paid an interzonal fare, implying that all of them took the train to Boston as opposed to alighting in Attleborough or other intermediate stations. This suggests that there are, at the most, 48 people now commuting from Boston to Providence on a daily basis via commuter rail. The Attleborough and Mansfield stations also have a few reverse-commuters, but as a whole, reverse-commuter boardings are little more than one percent of the 6,300 daily boardings on the Attleborough Line.

Given that downtown Worcester is the only major employment center on the proposed rail lines which can be reasonably well served by the rail extension (just as Providence is the only one on the Attleborough Line), it appears that reverse commuting will be a negligible component of overall ridership.

Non Work Trips

Non work trips often occur in non-peak hour and are often associated with particular activities such as shopping, school, medical visits or recreation. There are a number of factors which limit the utilization of commuter rail for such trips. For example:

- Many activities that are not work or school oriented occur in off-peak periods when rail service would be less frequent and roads less congested.
- Many social and recreational activities involve groups of individuals, such as families or friends, who would find the costs of driving and parking reduced on a per person basis while the cost of rail commuting would not experience a group economy.
- Many shopping and medical trips are likely to be local in nature which would not be served by intercity commuter rail.
- The longer distance shopping and medical trips may involve circumstances unlikely to encourage use of public transportation of any kind. For example, longer distance travel for shopping might involve a substantial number of parcels which would make the automobile a more convenient choice. Longer distance medical trips might suggest a more serious illness or impairment, again suggesting the likelihood of an automobile trip.

As a result, the importance of non-work travel is deemphasized in this study.

While reverse commute and non-work travel are not the focus of the study, their contribution can be accounted for in a rough cut manner that is sufficient for the level of a feasibility study. Trips from these market groups can be extrapolated as a percent of work trip commuting based on experience on the MBTA Commuter Rail System. The ridership forecasting analysis is therefore limited to projections of work trip commuting.

Work Trip Commuting

The number of work trips to and from central Boston was developed by the Central Transportation Planning Staff by expanding journey to work data from the U.S. Census of 1980 first to current levels and then to the year 2010, based on rate of growth in suburban populations and central Boston employment.

In the study area as a whole, the number of work trips to central Boston was projected to increase by about one half by the year 2010. In the city of Worcester, itself, the increase was on the order of 35%, while some of the more suburban towns closer to Boston would have higher growth rates. Clearly, the housing cost increases in Boston and the growth of the Metro West area have contributed to an expansion of the Boston commuter market.

5.2 THE WORCESTER/MARLBOROUGH/MILFORD MARKET AREA

This section describes what the market area for riders on the proposed rail service to Worcester, Marlborough and Milford is and how it was defined. As a part of this description, there is a brief discussion of the current market conditions, how they came about and how they are expected to evolve in the future.

Factors Defining a Market Area for New Rail Service

Several factors help determine the extent of the market area for a new commuter rail service. The majority of commuter rail trips are work trips. It follows that in defining a market area for proposed new commuter rail service, it is important to look first at how accessible the area currently is to the employment centers to which it will be connected by the new rail service. In the case of the proposed Worcester/Marlborough/Milford rail extensions, those employment centers are Boston and to a lesser extent Cambridge. The level of accessibility is usually related to how strongly oriented the market area is to Boston, and the strength of that orientation is another important factor in determining the size of the market.

It is also necessary to consider existing transit services. Their locations may highlight areas which may be "underserved" by transit and provide boundaries for the potential market area for new service. The market size is also a function of the locations of proposed rail stations and the ease of access to those stations from surrounding communities.

Defining the Worcester/Marlborough/Milford Market Area

The Boston CBD is an important employment center for residents of the I-90/I-495 area and Central Massachusetts. Trends in housing costs and labor availability during the 1980s have strengthened what in 1980 was already a strong economic relationship between Boston and this region. Continuation of these trends into the future combined with worsening auto commute travel times into Boston suggest that the market for rail service from Central Massachusetts and the I-90/I-495 region to Boston can be expected to grow.

The Worcester/Marlborough/Milford area is well connected by highway facilities to Boston. The Massachusetts Turnpike is the most important of these. Also very important are Route 9 and to a lesser extent Route 20. Interstate 495 serves as a feeder to these east-west routes from communities such as Marlborough and Hopkinton.

Boston employment rose by approximately 50,000 between 1980 and 1987. Given its accessibility to Boston, it is not surprising that during the 1980s the number of people living in the I-90/I-495 area and Central Massachusetts and working in Boston has increased significantly. Another factor leading to this increase is that of housing costs. From 1980 to 1987, the Boston area real estate market experienced dramatic increases in housing costs and the rental market had extremely low vacancy rates. The average housing unit cost in Boston itself rose from $63,000 in 1980 to $178,000 in 1988, or 182%. In a suburb such as Needham, the increase was from $84,000 to $235,000, or 180%. In Worcester, the average housing unit cost went from $37,000 in 1980 to $117,000 in 1988, a 216% increase; many other communities at considerable distance from Boston experienced similar changes ("The Demographics of Commuting in Greater Boston", a CTPS Report as a portion of the Transportation Plan for the Boston MPO Region, October, 1989).

As employment in Downtown Boston expanded, a significant number of new employees were forced to live further away where more affordable housing was available and to commute from longer distances to work than in 1980. Because the cities and towns in the I-90/I-495 area and Central Massachusetts are well connected via highways to Boston, they experienced significant growth in the number of residents working in Downtown Boston. The "push" factors of good highway connections and lower housing costs were accentuated by the fact that while employment growth was booming in the Boston area, employment growth in most of Central Massachusetts was relatively slow and unemployment rates were higher. In some labor market sectors, the labor pool in the immediate Boston area was exhausted and employers had to draw from further away. Central Massachusetts and the I-90/I-495 region, with their accessibility to Boston, availability of affordable housing and labor supply, grew significantly as a source of Downtown Boston employees during the 1980s.

Current projections of employment growth in downtown Boston along with continued low unemployment rates and high housing costs suggest that more and more people will be working downtown but commuting from further away. Meanwhile current traffic conditions on Route 9 and the Massachusetts Turnpike are rapidly becoming more congested. Projected traffic conditions show that auto commuting times to downtown Boston will be significantly longer than at present by the year 2010. This suggests that the towns and cities in the market area for the proposed rail service will constitute a significantly larger potential Downtown Boston-oriented rail market by the year 2010 than they do now.

Market Area Boundaries and Communities

In addition to the degree of Boston orientation and general accessibility, another important factor which helps to geographically define the market area for new Worcester/Marlborough/Milford rail service is that of existing transit service and service assumed to exist in the horizon year for the project, 2010. The current Fitchburg Line, with station stops in Littleton, Acton and Concord, defines the northern edge of the market area. The Franklin Line, with its extension to Bellingham and Milford, defines the southern edge of the market area. The eastern boundary is defined by the service to Boston which exists from Framingham. Surveys of rail service in the Boston area have shown that people are willing to travel a limited distance to reach a rail station. This information combined with 1980 Journey-to-Work information, which shows that there were few work trips to Boston from communities further west than Spencer, helped to determine the western boundary of the market area.

The market area is perhaps most obviously determined by the locations of the proposed rail stations. Surveys of existing commuter rail service have shown that the market for a station is usually largest in the town where the station is located. While this may be partially attributed to the fact that rail stations are often located in the larger population centers of a given market area, it is also true that people are usually only willing to travel a few miles (with some exceptions, particularly line terminus stations) to reach a rail station. The following communities have rail stations located within them in at least one of the rail alternatives:

Framingham
Ashland
Westborough
Grafton
Worcester
Holliston
Milford
Southboro

In addition to these communities are the cities and towns from which potential riders can easily reach the rail stations. The following communities are within reasonable reach of the above cities and towns and are more accessible to the proposed stations than they are to any stations assumed to exist on other rail lines in 2010:

Sherborn
Hopkinton
Upton
Marlborough
Hudson
Berlin
Northbridge
Northborough
Shrewsbury
Auburn
Millbury
Spencer
Boylston
West Boylston
Oxford
Charlton
Sutton
Millis

Market Area Work Trips to Boston

Once the market area is defined geographically, it must be defined in terms of potential users of the proposed rail service. Recent surveys of Boston area rail lines have shown that approximately 90% of commuter rail trips are work trips and nearly all of these are to jobs in Boston. While there are many people who both live and work within the market area, it is unlikely that a significant proportion of them would be served by radial, Boston-oriented rail service. There probably are some people who, for example, live in Worcester and work in Framingham and could conceivably use the train to travel to and from work. However, few of them would likely be willing to drive or take a bus to the Worcester station, wait for the train, ride it to Framingham, then wait for a bus or other transportation to their places of employment when they can drive from home to work in what is probably less total time. People who work in the market area can also, in most cases, park at work without much added cost or time. Traffic congestion between cities and towns in the market area is reasonable compared to congestion approaching Boston, and parking is much cheaper and more readily available than in Boston.

For these reasons the modeling procedure used to forecast rail ridership in this study was concerned primarily with work trips from the market area to Boston. Further development of these work trips, the creation of a trip table and the application of the travel demand model is described in the following section.

5.3 TRAVEL DEMAND MODELLING METHODOLOGY

Summarized below is the modelling method used to create ridership estimates for the bus and rail alternatives outlined for this study. A more detailed account of the methodology may be found in Appendix D.

The Central Transportation Planning Staff (CTPS) travel demand procedures are a result of 25 years of urban transportation planning experience in the Boston metropolitan area. The actual travel demand forecasting models were originally developed by Peat, Marwick, Mitchell & Co. and Alan M. Voorhees & Assoc. as part of earlier travel studies in the region. These travel demand forecasting models have since been revalidated resulting in the reestablishment of confidence that they can adequately estimate travel patterns and transit ridership to the level of accuracy that can be obtained by current practice in large metropolitan areas. These models are applied within the U.S. Department of Transportation-supported Urban Transportation Planning System (UTPS) software package.

The modelling process as applied to the Worcester/Marlborough/Milford study is a shortened version of the so-called 4-step process, the four steps being trip generation, trip distribution, mode split and assignment. The first two steps culminated in the creation of a trip table containing existing and year 2010 work trips from cities and towns in the Worcester/Marlborough/Milford commuter rail extension market area to the downtown Boston area. This was accomplished by using information from the Central Artery/Third Harbor Tunnel Project and recently developed Boston Metropolitan Planning Organization (MPO) Commuter Source Region data along with 1980 Journey-to-Work information. This process is described below, after which the network assumptions and the mode choice model are discussed.

Estimation of Work Trips to Boston from the Market Area

Since the majority of the Worcester/Marlborough/Milford Commuter Rail Extension study area is outside of the typical CTPS regional study area, existing CTPS regional person trip tables could not be used for this analysis. Consequently, a recently developed Boston Metropolitan Planning Organization (MPO) Commuter Source Region consisting of 339 cities and towns was used for this analysis. The MPO Commuter Source Region was developed as part of the CTPS work on the long range transportation plan for the Boston region and consists of 242 cities and towns in eastern Massachusetts, 55 in southern New Hampshire, 30 in Rhode Island, eight in northeastern Connecticut, and four in southern Maine, as shown in Figure 5-1.

For this analysis, existing and year 2010 work trips from all of the cities and towns in this

MPO Commuter Source Region to the downtown Boston area were developed based on 1980 Census Journey-to-Work data, socioeconomic information for the cities and towns, and work trip attraction control totals for the downtown Boston area developed as part of the Central Artery/Third Harbor Tunnel Project. This regional approach was used for this analysis rather than developing work trip estimates solely for the Worcester/Marlborough/Milford Commuter Rail Extension study area because it was very difficult to determine the share of downtown work trips that could be attributed to the study area without considering the growth in downtown work trips from other areas in the region. A more detailed description of this process is presented in Appendix D.

The resulting estimated 1987 and 2010 work trips destined to downtown Boston from cities and towns located in the Worcester/Marlborough/Milford market area are presented in Table 5-2 along with population figures. These work trips represent the major source of potential commuter rail passengers. The actual share of work trips that would use the proposed commuter rail service was determined through the application of the mode choice model as described below. Surveys of Boston area commuter rail services have shown that 90% of commuter rail trips are work trips. The non-work trips in this study were estimated outside of the modelling process and added to the work trip boardings produced by the model for each of the alternatives.

Networks

The work using the CA/THT and MPO Commuter Source Region data along with 1980 Journey-to-Work information produced a trip table which contains the number of trips from each community in the market area projected to go to the Boston CBD in 2010. Computerized representations of the transit and highway networks were then built for simulating travel patterns and for producing inputs to the mode split step of the modelling process.

In addition to the services of interest in this study, the 2010 transit network includes some important additions to the existing transit system. The most significant of these is the extension of the Franklin Line to Bellingham and Milford. Express bus service from Worcester and Marlborough was included depending on the alternative being tested. In general, if rail service to a particular community existed in an alternative, bus service from that community to Boston was eliminated.

The Mode Choice Model

Once the trip table work and the networks are complete, the next step in the modelling process is to create the inputs to the mode choice model and to run it. The mode choice model was specifically adapted to this study and the market area for the proposed new rail service. It is a traditonal regionally derived model that allocates trips to the auto and highway modes. It accounts for all characteristics of the travel modes and travellers that have a bearing on the choice of mode. Its chief inputs are travel time, distance and cost. The transit travel times are made up of the travel time to the station, wait time at the proposed station (which is a function of train service frequency) and actual rail travel time from the proposed station to Back Bay Station or South Station. There are also penalty times added to reflect the onerousness of driving to a station and transferring from one transit service to another.

New 1987 highway travel times and distances for use in the mode choice model were developed by first expanding the 1987 CTPS regional highway network. The highway network in the Worcester area was added to the existing CTPS regional highway network using the MINUTP microcomputer transportation planning package. Actual traffic counts or estimated volumes were then entered on each link of the study area portion of the network. Congested highway travel times and distances from the study area portion of the network to Boston were then developed based on these counts and volumes in conjunction with the CTPS assigned traffic volumes in the rest of the network. These highway times and distances were then transferred to the mainframe computer for use in the UTPS mode choice model. The same information for the 2010 horizon year was developed using the 2010 CTPS regional highway traffic assignment which assumes the implementation of the Central Artery/Third Harbor Tunnel Project. The traffic counts and estimated volumes on the added Worcester portions of the network were factored to 2010 based on historical growth rates and population and employment change in the area. These estimated 2010 volumes were used together with the 2010 CTPS assignment to create 2010 congested highway travel times, which again were transferred to the mainframe computer for use in the UTPS mode choice model.

The model also accounts for transit fares, which on the proposed rail lines were based on the extension of the current MBTA fare zone system. Auto ownership rates, operation costs and parking costs are also included in the model.

The model, using all inputs described,was applied to the trip table to produce transit trips. In conjunction with the transit network, transit boardings for each of the proposed alternatives were produced through the assignment process. These boardings were evaluated and analyzed based on knowledge of current service and ridership conditions elsewhere in the MBTA system as well as in terms of other studies of potential new rail service. The model was then adjusted and rerun to produce more refined ridership estimates which are presented below.

5.4 TRAVEL DEMAND MODELLING RESULTS

Table 5-3 presents the rail station boardings and Table 5-4 the bus boardings produced for each of the alternatives in the Worcester/Marlborough/Milford Commuter Rail Extension Feasibility Study. While the trip table developed and assigned by the model to produce these boardings consists entirely of work trips to the Boston CBD, the figures in Tables 5-3 and 5-4 have been augmented to include non-work trips. As noted previously, these non-work trips represent approximately ten percent of total commuter rail boardings.

The alternatives include a Bus Alternative and four rail alternatives. Under each of the rail alternatives, express bus service is retained only if no rail service exists to compete with between Worcester and Boston. In all alternatives, rail service to Milford from the Franklin commuter rail branch is assumed to exist. As a result, the existing express bus to Milford is assumed to terminate in Medway.

The Bus Alternative - The Bus Alternative includes express bus service from Worcester, the semi-express service from Worcester through Shrewsbury and Westborough, and express service from Shoppers World, Medway and Marlborough. All of these bus services have peak period headways of 30 minutes. The semi-express service is improved over its present-day service by accessing the Massachusetts Turnpike at Exit 12 and eliminating the stop at Shoppers World. In Table 5-3, it is clear that the Bus Alternative does not attract as many travellers as the rail alternatives. The express bus services do not offer time savings to trip-makers over the auto mode as do the rail services. As a result the transit mode shares are lower for many communities in the Bus Alternative than in the rail alternatives.

Alternative 1 - This alternative consists of new commuter rail service from Worcester to Boston with station stops in downtown Worcester, North Grafton, Westborough, Ashland and the existing Framingham station. The service is then operated as an express between Framingham and Back Bay Station. Its headway is assumed to be 30 minutes. Existing private express bus service from Worcester to Boston is dropped from the network while express bus services from Marlborough to Boston and semi-express service from Worcester, Shrewsbury and Westborough are included. Neither the Marlborough service nor the semi-express service attracts any trips due to the faster rail service from Worcester, Westborough and Ashland. These circumstances result from the traditional all-or-nothing assignment process; a small number of transit users would probably use the bus services because of scheduling differences or more convenient access. The Framingham rail station, which is located in the largest single market community in the study area, attracts the largest number of travellers. Westborough, designed to be easily accessible from the Massachusetts Turnpike and I-495, is the next largest station in terms of total boardings. The smallest is the North Grafton station, which is less accessible to potential rail riders.

Alternative 2 - Alternative 2 contains the Worcester line as in Alternative 1 and includes the extension of current Framingham local service to Milford with stops in East Holliston, Holliston and Milford. The headway for Milford rail service is assumed to be 30 minutes. The Milford station on the Framingham line must compete with the other Milford station to the south which is on the extension of the Franklin line, and, to a lesser extent, with express bus service to Boston from Medway. As a result, the only station on the Milford extension of the Framingham line which attracts a sizeable number of travellers is the East Holliston station, and some of these travellers are simply being taken away from the Ashland station on the Worcester rail line.

Alternative 3 - Alternative 3 includes service on both the Milford and the Marlborough branches off of the Framingham Line. No service is provided to Worcester. On each of the branches, both local and express Framingham - Boston service is provided, and each branch has service with a combined headway of 30 minutes. Because the local and express lines from each of the branches all stop at the existing Framingham station, it has service with a combined headway of 15 minutes. The station stops on the Milford branch are as in Alternative 2. Those on the Marlborough branch are at Northboro Road and Main St. in Southboro, and at California Ave. and Salem End Rd. in Framingham. Current express bus service to Marlborough is dropped and express bus service to Medway is as in all alternatives. In Alternative 3, express bus service from Worcester is included in the network, as is the semi-express service. The Northboro Rd., California Ave. and Salem End Rd. rail stations all contribute to the fact that, as in Alternatives 1 and 2, the semi-express service does not have any boardings. As in Alternatives 1 and 2, Framingham station attracts the largest number of travellers. The Salem End Rd. station attracts a large number of boardings because of its proximity to Route 9 and accessibility to parts of Framingham and Sudbury. Northboro Rd. is somewhat analogous to the Westborough station in the first two alternatives in its location, which is directly accessible from I-495.

Alternative 4 - Alternative 4 consists solely of express service on the Marlborough branch overlaid on existing local Framingham service. The Marlborough branch has aheadway of 30 minutes and the same station stops as in Alternative 3. Private express bus service to Marlborough is dropped. The 30 minute express rail service attracts more travellers to the Marlborough branch than service in Alternative 3; some of these added trips are diverted from the Fitchburg Line and some are due to higher transit mode shares. Framingham station boardings are higher than in Alternative 3 because they include a number of travellers who were using the Milford branch in that alternative.

The figures in Table 5-3 imply that a substantial demand for service to Boston from the study area exists in 2010 . As specified in the travel demand model set, the rail mode is competitive with auto in terms of both travel time and cost. This is largely due to the heavy congestion forecast for Route 9 and the Massachusetts Turnpike, which are the major highway access paths from the study area to Downtown Boston, and to the increasingly constrained, hence costly, downtown parking. These conditions, combined with ample parking at rail stations, underlie the rail ridership projections. The rail boardings are not unreasonably high when compared to certain existing station boardings. Boardings at the Providence station on the Attleboro Line, for example, were 666 in the May, 1989 MBTA audit, yet Providence had only about three-fifths the number of work trips to Boston that Worcester had in 1980.

Mode Shares

Transit mode shares of work trips to Boston from communities in the market area reflect the impact of 2010 traffic congestion on access routes to Downtown Boston and high Boston parking costs. Worcester's transit mode share in the first two alternatives is approximately 60%, Shrewsbury's is 55% and Ashland's is approximately 53%. These percentages may appear to be very high, but it is important to remember that these splits reflect the percentage of work trips to the Boston CBD taking transit, not the total work trip mode splits for these communities. Even in 1980, the U.S. Census showed many cities and towns on rail lines as having transit shares similar to these. For example, Concord's transit mode share of work trips to Boston was 56% in 1980, Ayer's was 50% and Franklin's was 65%.

Station Access Modes

Table 5-5 breaks down total person trip boardings at each station in each alternative by station access mode. Walk, kiss & ride and park & ride are included. Feeder bus service to proposed rail station in Worcester was included in the model, but because of station parking availability and transit user resistance to having to transfer between transit lines, these services were not projected to attract any users. It is possible that in reality these feeder routes would attract some very modest ridership, but not enough to justify the service.

As shown in Table 5-5, a very small number of people are expected to walk to the proposed stations. The station markets are spread over several communities in most cases and surveys have shown that people will not usually walk more than half a mile to reach a rail station. Additionally, many of the proposed stations are in sparsely populated areas, such as those in North Grafton and Holliston. The Worcester station is located near downtown Worcester but is not easy to walk to from most parts of the city.

The demand model set does not distinguish park & ride from kiss & ride travellers. However, recent surveys of Boston area commuter rail stations show that approximately eight percent of rail riders reach rail stations via the kiss & ride mode. This eight percent is assumed to hold true for the proposed stations in order to estimate parking demand under each of the alternatives. In reality, every station is different in this way and the actual proportion depends on the station location and parking availability. A vehicle occupancy rate of 1.12 persons per auto is assumed, along with a ten percent daily parking space turnover rate. The latter refers to the number of parking spaces which become free and can be used by more than one rail rider over the course of a day. This is consistent with the finding that about ten percent of commuter rail trips are for shopping or other non-work purposes. Combining all these assumptions produces estimates of daily parking demand at each proposed rail station in each alternative.

FIGURE 5-1

MPO Commuter Source Area

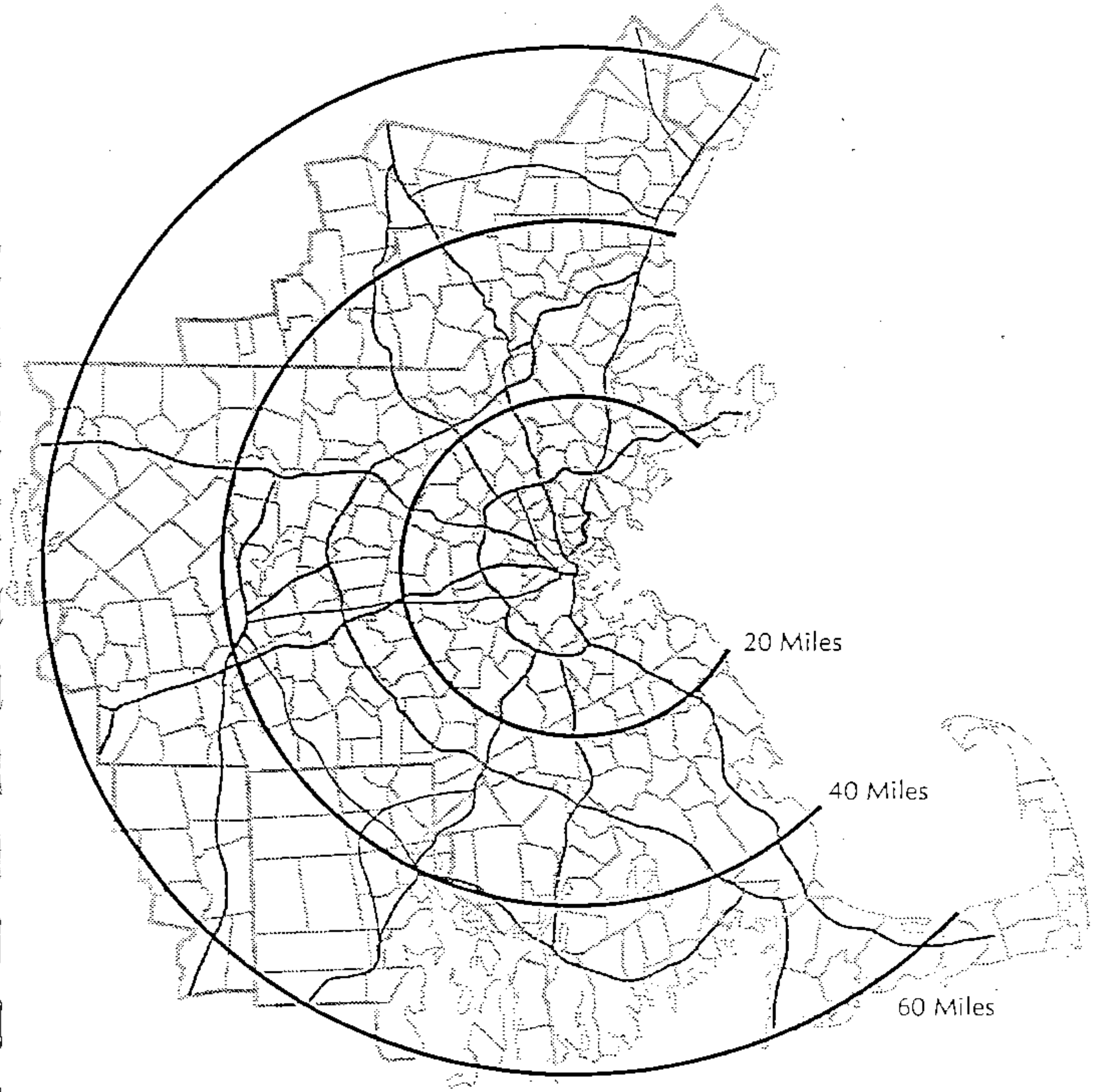

TABLE 5-2

WORCESTER COMMUTER RAIL EXTENSION STUDY AREA

City/Town	Est. 1987 Population	Est. 2010 Population	Est. 1987 Work Trips to Downtown	Est. 2010 Work Trips to Downtown
Framingham	63800	65100	2640	3710
Sudbury	14120	14000	700	960
Ashland	11200	14000	170	290
Holliston	12950	14000	300	440
Medway	9500	10810	210	330
Mendon	3530	4150	30	40
Hopedale	3980	4060	20	30
Milford	24280	24480	320	450
Hopkinton	8700	9400	210	310
Southborough	6430	7700	210	350
Marlborough	31150	35250	360	570
Hudson	17700	18250	100	150
Berlin	2230	2250	40	50
Northborough	11340	11620	120	170
Westborough	13100	13600	290	370
Upton	4300	4910	30	40
Northbridge	12450	12750	20	30
Grafton	11900	13620	30	50
Shrewsbury	22590	23120	160	250
Boylston	3540	3630	20	30
W. Boylston	6030	5660	10	10
Worcester	166000	170000	780	1030
Millbury	11820	11460	30	40
Sutton	6600	8360	30	50
Oxford	12370	12960	50	80
Auburn	14400	14400	30	80
Leicester	9650	10090	40	60
Paxton	3830	3820	20	20
Holden	13770	14090	20	30
Spencer	11600	12480	50	80
Charlton	8300	12320	20	30

TABLE 5-3

TOTAL RAIL AND BUS BOARDINGS

Daily Inbound Person Trips

Station	Bus Alt	Alt 1 2010	Alt 2 2010	Alt 3 2010	Alt 4 2010
Framingham		1230	1230		
Ashland		630	360		
Westborough		920	920		
North Grafton		120	120		
Worcester		880	880		
Framingham				1320	1620
Salem End Rd.				810	820
California Ave.				550	550
Main St.				180	180
Northboro Rd.				580	730
East Holliston			430	460	
Holliston			130	150	
Milford			180	180	
Rail Subtotal*	0	2550	3020	2910	2280
Bus Subtotal	1530	40	40	950	950
TOTAL*	1530	2590	3060	3860	3230

*Framingham Station excluded

TABLE 5-4

BUS BOARDINGS

Daily Inbound Person Trips

Origin	Bus Alt 2010	Alt 1 2010	Alt 2 2010	Alt 3 2010	Alt 4 2010
Worcester/ Grafton	910	0	0	910	910
Shrewsbury/ Westborough	270	0	0	0	0
Marlborough/ Southboro	310	0	0	NA	NA
Medway/ Medfield	40	40	40	40	40
Bus Subtotal	1530	40	40	950	950

TABLE 5-5

DAILY PERSON TRIPS BY STATION ACCESS MODE, YEAR 2010

ALT 1 Worcester

Station	Total Person Trips	Walk Person Trips	Auto Person Trips	Kiss'n'Ride Trips *	Park'n'Ride Trips	Park'n'Ride Vehicles **	Daily Parking Demand ***
Framingham	1230	30	1200	100	1100	990	890
Ashland	630	20	610	50	560	500	450
Westborough	920	0	920	70	850	760	680
N. Grafton	120	0	120	10	110	100	90
Worcester	880	20	860	70	790	710	640
TOTAL	3780	70	3710	300	3410	3050	2740

ALT 2 Worcester and Milford

Station	Total Person Trips	Walk Person Trips	Auto Person Trips	Kiss'n'Ride Trips *	Park'n'Ride Trips	Park'n'Ride Vehicles **	Daily Parking Demand ***
Framingham	1230	30	1200	100	1100	990	890
Ashland	360	20	340	30	310	280	250
Westborough	900	0	900	70	830	740	670
N. Grafton	120	0	120	10	110	100	90
Worcester	880	20	860	70	790	710	640
TOTAL	3490	70	3420	270	3150	2810	2530
E. Holliston	430	10	420	30	390	350	310
Holliston	130	10	120	10	110	100	90
Milford	180	10	170	10	160	140	130
TOTAL	740	30	710	60	650	580	520

TABLE 5-5

ALT 3 **Milford and Marlborough**

Station	Total Person Trips	Walk Person Trips	Auto Person Trips	Kiss'n'Ride Trips *	Park'n'Ride Trips	Park'n'Ride Vehicles **	Daily Parking Demand ***
Framingham	1320	30	1290	100	1190	1060	950
Salem End Rd.	810	50	760	60	700	620	560
Calif. Ave.	550	0	550	40	510	450	410
Main St.	180	20	160	10	150	130	120
Northboro Rd.	580	10	570	50	520	470	420
TOTAL	3440	110	3330	270	3060	2740	2460
E. Holliston	460	10	450	40	410	370	330
Holliston	150	10	140	10	130	120	100
Milford	180	10	170	10	160	140	130
TOTAL	790	30	760	60	700	620	560

ALT 4 **Marlborough**

Station	Total Person Trips	Walk Person Trips	Auto Person Trips	Kiss'n'Ride Trips *	Park'n'Ride Trips	Park'n'Ride Vehicles **	Daily Parking Demand ***
Framingham	1620	30	1590	130	1460	1310	1180
Salem End Rd.	820	50	770	60	710	630	570
Calif. Ave.	550	2	550	40	510	450	410
Main St.	180	15	160	10	150	130	120
Northboro Rd.	730	10	720	60	660	590	530
TOTAL	3900	110	3790	300	3490	3110	2800

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* Proportions taken from CTPS surveys.

** Assumed vehicle occupance rate of 1.12.

*** Assumed daily parking turnover rate of 10%.

CHAPTER 6

OPERATIONAL ISSUES

6.1 OPERATING SPEEDS

Alternative 1 - Worcester Service

The addition of commuter service to Worcester would add approximately 22.9 miles to the current Framingham service route. This trackage is part of Conrail's main freight line to the Boston area from the rest of their system, connecting at Selkirk Yard (Albany, N.Y.). As such, it is a well maintained, centralized traffic control signalled line. The current speed for freight is 50 miles per hour. The line also hosts six Amtrak intercity passenger trains, for which the maximum speed is 60 miles per hour. There are some speed restrictions on the line due to curvature, special features such as bridges or urban areas. Leaving Framingham station there is a 30 mph restriction for two-tenths of a mile, followed by 1.45 miles of 50 mph. The next 12.9 miles are at the maximum 60 miles per hour, then a 55 mph section of 0.6 miles with 60 resuming for 5.4 miles. As the Worcester area is entered a 50 mph limit is encountered for 1.8 miles, followed by about 0.3 miles of 25 mph in the immediate Worcester Yard and Amtrak station area. (Refer to Figure 6-1 for speed profile)

Alternative 2 - Worcester and Milford Service

The Worcester portion of this alternative remains the same as Alternative 1 (Worcester only). The Milford service replaces the peak period portion of the current Framingham service and will provide local service in the Framingham-Boston corridor.

Milford Branch

The addition of service to Milford would add approximately 12.3 miles to the existing Framingham line. This line is currently a Conrail freight branch and receives little service beyond Framingham proper; material comprising chemicals and solvents is a major product on this portion of the line. The recently closed General Motors automobile assembly plant is located on this branch in Framingham. Beyond the auto plant, service has been on an as-needed basis only. Consequently, speeds are relatively low, 25 mph for freight. The last 5.3 miles of the route into Milford has been out of service for a number of years. Of the last 5.3 miles, the first 2.8 miles of track remains in place, but beyond that no trackage remains. Operating speeds for passenger service over this line were therefore based on reconstructed trackage built to passenger standards. No signal system currently exists on the line, but a signal system was assumed for the development of service speeds.

Alternative 3 - Marlborough and Milford Service

This alternative utilizes both branch lines - Milford and Marlborough - to extend the service area of the Framingham Line. The two lines are fairly well separated, and therefore can serve different potential market areas. A plan for the coordinated operation of the two lines is the basis of this alternative. Alternating express and local trains on each line will constitute the peak period service.

Milford Branch

Operating speeds would be the same as described under Alternative 2. (Refer to figure 6-2 for Speed Profile)

Marlborough Branch

The service to Marlborough would utilize a 10.4 mile long portion of a Conrail branch line currently operated for 25 mph freight service. This service is provided by a local train originating daily at Framingham Yard. LPG gas is a major product on this line. This commodity factor results in a line in better condition than might otherwise be expected from 25 mph track. Conrail is currently replacing ties and exploring the possibility of increasing clearances on this line to permit passage of automobile rack cars. Should this relatively premium, time-sensitive traffic be added, it is likely that speed limits would be increased. For the purpose of schedule development, it is assumed that the line will be rehabilitated to passenger standards with maximum speeds of 60 miles per hour.

Alternative 4 - Marlborough Service

Operating speeds would be the same as the Marlborough portion of Alternative 3. (Refer to Figure 6-3 for Speed Profile)

6.2 SCHEDULING REQUIREMENTS

The running times from Framingham to Worcester, Milford and Marlborough were simulated using a Train Performance Calculator (TPC). This tool can recreate the optimal running times for a train based on the physical conditions of the trackage, speed restrictions, equipment characteristics and train sizes. An allowance is made in the TPC for station stops and the required acceleration and deceleration. The running times for Framingham-Boston were estimated using current MBTA and Amtrak schedules. Local running times between Framingham and Boston are 45 to 50 minutes. Express times are approximately 35 minutes.

Alternative 1 - Worcester Service

For this study, the TPC simulated typical MBTA locomotive and equipment sets over the Conrail line. Station stops were included at Ashland, Westborough, and North Grafton as well as the end points. The running time between stations is shown in Table 6-4.

This line has recently been reduced from double track to single (west of CP 33) with the retired line to be removed for much of the distance. A short portion of the former second main line remains in place in the Worcester area as a non-controlled siding for industrial and freight yard access. The new commuter train service will require the addition of a controlled passing siding to maintain scheduling flexibility.

Under Alternative 1, trains originating in Worcester during the morning peak period, or destined there during the evening peak period, will run local between Worcester and Framingham making intermediate stops in Grafton, Westboro and Ashland, and will run express between Framingham and Back Bay Station, making no station stops. Local service from Framingham to Boston will continue on the current pattern. The resulting time for a Worcester-Boston trip is 67 minutes.

Off peak schedules are operated from Worcester through Framingham on a local basis. Service levels at Framingham are essentially unchanged. The late night Worcester to Boston train included in the off peak schedule could also serve Boston area patrons of Centrum performances. The resulting time for an off peak Worcester to Boston local trip is approximately 82 minutes.

Train service to Boston is structured so that all current arrival markets are served. Trains from both Worcester express and Framingham local services are scheduled to arrive on about thirty minute headways during the morning peak period (i.e. seven o'clock to nine o'clock). Similarly, during the afternoon peak (i.e. four to six o'clock) half hour headways are planned for both express trains to Worcester and locals to Framingham. Table 6-5 contains a weekday schedule for this service.

Alternative 2 - Worcester and Milford Service

The TPC simulated operation over the Milford branch line as expected to be reconstructed. Station stops were included at East Holliston and Holliston as well as the end points. The running time between stations is shown in Table 6-4.

In order to match service requirements with demand, Milford trains were assumed to replace current Framingham trains during the peak period. As with Alternative 1, half hour service to/from Boston is scheduled during peak periods for each branch. Trains originating in Worcester during the morning peak, or destined there in the evening run express between Framingham and Back Bay station making no station stops. Local service will operate from Milford on the current Framingham pattern. The resulting time for a Milford-Boston trip is 75 minutes. Off peak schedules are operated from Worcester through Framingham on a local basis. Off peak service from Framingham to Milford would comprise a shuttle service scheduled to coordinate meets with Worcester trains. Service levels at Framingham are essentially unchanged. The proposed daily schedule for this alternative is presented in Table 6-6.

Alternative 3 - Marlborough and Milford Service

The schedule for this alternative is shown in Table 6-7. Details of the Milford and Marlborough portions are as follows:

Milford Branch

This service is coordinated with service to Marlborough. During peak periods a through train from Milford will operate to Boston on half hour headways. The trains will alternate between running local from Framingham to Back Bay and running express. When the Milford Line is operating as express the Marlborough will be local and vice versa. All trains will run local between Framingham and Milford. Local running time between Milford and Boston would be approximately 75 minutes, while express time would be one hour. It would be possible to transfer at Framingham for the express from Marlborough and vice-versa.

As with Alternative 2, shuttle service will be operated to/from Milford during the off-peak.

Marlborough Branch

This service is complementary to the Milford portion previously described during peak periods. When expresses serve Milford, locals will serve Marlborough. Stops on the Marlborough Branch were assumed at Salem End Road and California Avenue in Framingham, as well as Main St. and I-495 (near Marlborough) in Southborough. The running times between Marlborough and Boston for locals and expresses are about 73 minutes and 58 minutes respectively. Unlike Milford, it is proposed that local service be provided to Marlborough during off peak hours.

Alternative 4 - Marlborough Service

To be competitive with other modes, peak period service to/from Marlborough would be express between Framingham and Back Bay. Run times for express service would be about 58 minutes. Peak period headways would be 30 minutes. The current half hour local service between Framingham and Boston would continue under this alternative. The proposed schedule is shown in Table 6-8.

6.3 LAYOVER FACILITIES

Alternative 1 - Worcester Service

Some provision for the overnight storage of train sets in Worcester will be necessary. Four sets of equipment are required for the early service on the Worcester trains. These train sets would be in position at Worcester from the previous evening's schedule. The layover facility would need to be equipped for light cleaning. It must be equipped with station power connections so that temperature of the equipment can be maintained without running the locomotive's headend power. Currently, no equipment is stored in the Framingham service, the operating pattern provides for all equipment to cycle back to Boston for the night and be positioned at Framingham in the morning. The additional distance and time required for this type of operation at Worcester makes this an undesirable option.

There are currently no suitable existing facilities in the Worcester area. Several sites are, however, available for the construction of such facilities both in Worcester proper and along the route from Framingham. One possible site is an unused industrial yard area in Westborough. Another is at the current Worcester passenger station where an unused former main track parallels the station track. This track could be developed as a layover facility, however it would necessitate the storage of the four train sets in end to end fashion. Such storage carries the risk of operational delays if one train set cannot be moved readily. The trackage available is connected at both ends which reduces the severity of such possible delay. There are other sites in the Worcester area on both Conrail and Providence and Worcester property which could be acceptable for development as layover facilities. Many of the Worcester sites have the advantage of being located away from residential areas in areas of current industrial or railroad use, reducing the potential for noise problems.

Wherever the layover facility is located, it should be a more efficient method of operation than returning the trains to Boston each evening and positioning them again in the morning. The savings in train miles and in crew time should yield returns sufficient to pay for the layover facility.

Alternative 2 - Worcester and Milford

Layover facilities will be required for overnight storage of equipment in both Worcester and Milford. As with Alternative 1, four sets of equipment are required for early service on Worcester trains. Similarly, provisions for overnight storage of four trains will be required on the Milford line. A good potential location for this layover extends form South Street in Holliston, southward along the tracks, to the New England Power Company easement in Milford.

Alternative 3 - Marlborough and Milford Service

Layover facilities will be required in both Marlborough and Milford for overnight storage of the eight train sets needed for early morning service to Boston.

Alternative 4 - Marlborough Service

As with the other alternatives, a layover facility accommodating four train sets will be required in Marlborough. This layover facility might be installed at the end of the line, extending westward from the Northborough Road Station site.

6.4 SERVICE PROVISION AND MANAGEMENT

Currently, providing peak service from Framingham to Boston requires 22 operational single-level coaches in four train sets (i.e., two five-car and two six car consists). MBTA has indicated its preference for using bi-level coaches for the extensions. The MBTA has a choice of continuing to use the existing 22 single-level coaches in combination with new bi-levels or to purchase all bi-levels and use the single-levels on other commuter lines.

While the capital and operating costs would differ if a mix of single- and bi-level cars were used, the relative differences between alternatives would not be affected by assuming all bi-levels. This occurs because the current Framingham local service forms the base upon which the additional service offerings which define the four rail alternatives are overlaid.

Although the 75% greater capacity of bi-levels (175 passengers vs. 100 for single levels) would warrant reductions in consist length if operated today, it is very likely that the anticipated growth in Framingham station boardings, offset by some diversion to express trips, would warrant more capacity in the 2010 horizon year. For simplicity sake, and since the focus of this study is on the relative merits of the alternative rail investments, an equivalent number of bi-level cars is assumed for the baseline Framingham local service.

Using the travel demand forecasts in Chapter 5, and cluster time arrival distributions, the consist requirements for the operating schedules depicted in Tables 6-5 through 6-8 can be derived. Table 6-9 presents the estimated locomotive, control car and trailer car requirements by alternative. The table comprises three sets of entries, i.e. new service requirements, Framingham service adjustments and net additional requirements. New service requirements comprise the additional equipment needed, above and beyond that required to operate the baseline level of Framingham service defined above.

It is expected that operating a new express service (whether to Worcester, Milford or Marlborough), which stops in Framingham, would divert a significant number of riders who previously took the local to the new express, since it offers a 15 minute travel time advantage at no increased cost.

Also, the coupling of Milford local trains in alternatives 2 and 3 to Worcester and Marlborough express services would serve all the same stations served by the current Framingham local, but would add new stops in Holliston and Milford. Hence, the existing Framingham local service would become redundant. To afford a fair and realistic comparison of the alternatives' cost, ridership and environmental consequences, it is appropriate that two conditions be met: First, each alternative must offer comparable service frequencies to key destinations such as Framingham and South Station. Second, the frequency of service offered should not exceed either the effective capacity of the Framingham-South Station line or the level of service for which demand is anticipated to exist.

For these reasons, a limit of four trains per hour (two each for two lines) was assumed at Framingham and South Station. With this limit and the comparable levels of service criterion, it is appropriate to eliminate the Framingham local service in favor of Milford local service in Alternative 2 and in alternating the Milford/Marlborough local service in Alternative 3.

Hence, the Framingham service adjustments in Table 6-9 reflect a reduction in coaches only for alternatives 1 and 4, whereas reductions in both locomotives and coaches (entire train sets) are indicated for alternatives 2 and 3.

The resultant net additional requirements portion of Table 6-9 simply reflects the difference after netting out the Framingham reductions. These net additional rolling stock requirements are carried forward in the capital investment requirements as well as the cost effectiveness results presented in Chapter 8.

6.5 WORCESTER - BOSTON CAPACITY ANALYSIS

Using a stringline chart containing the proposed MBTA trains, AMTRAK trains and CONRAIL's freight trains a capacity analysis of the rail line between Worcester and Boston was made: TPC simulations were also used to pinpoint the ideal locations for the passing sidings on the Milford and Marlborough lines. The conclusions of these analyses are as follows:

- The few added trains between Framingham and South Station would not cause any capacity constraints in this segment of line nor change any freight windows provided that midday storage of trains is not required at Milford, Marlborough or Worcester. If midday storage is required at the outer points, freight windows would be changed, and it is recommended that full reserve running capability be installed between Boston and Framingham by completing the link between CP11 and Framingham on Track 1 to compensate for the reduced capacity.

- Between Worcester and Framingham, rather than construct a passing siding at North Grafton as originally planned, the siding (or maintrack) should instead be placed between MP 40.3 and Worcester if only peak hour trains are operated to Worcester. If off-peak service is operated as well, double track with reverse running should be restored between CP 33 and Worcester because 44 trains per day would be operating in this link.

- Taking the added Framingham trains in isolation without considering growth on other lines (except the Old Colony), there would be capacity in South Station to handle the added Framingham line trains. If there is growth on other lines also, whether capacity exists for them depends upon the proposed schedules.

- The ideal location for the sidings on the Milford and the Marlborough lines would place the east end of the sidings 12 minutes from Framingham on both lines and the west end of the sidings 8 minutes from Milford and Marlborough. On the Milford line, this would ideally place the siding between MP6 and 8. On the Marlborough line, the siding would be ideally located between a point 2.5 miles west from the junction at Framingham Center to Oak Hill Road. The California Avenue station may or may not be in these siding limits depending upon the final station location. If the sidings can not be placed in the ideal location, the achievable headways will be increased 2 minutes for each minute the siding is located from the ideal location.

FIGURE 6-1. SPEED PROFILE

WORCESTER LINE

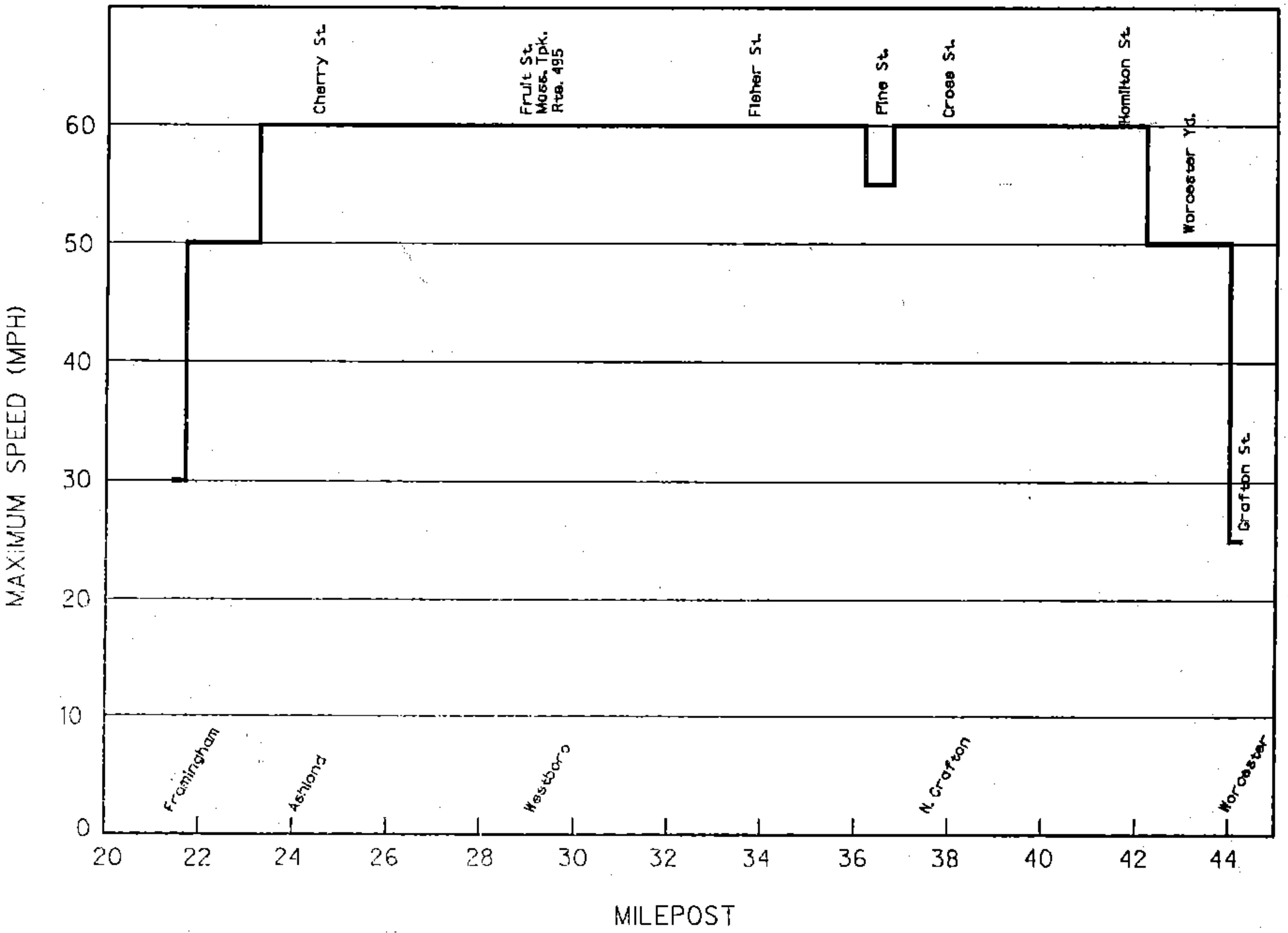


FIGURE 6-2. ASSUMED SPEED PROFILE

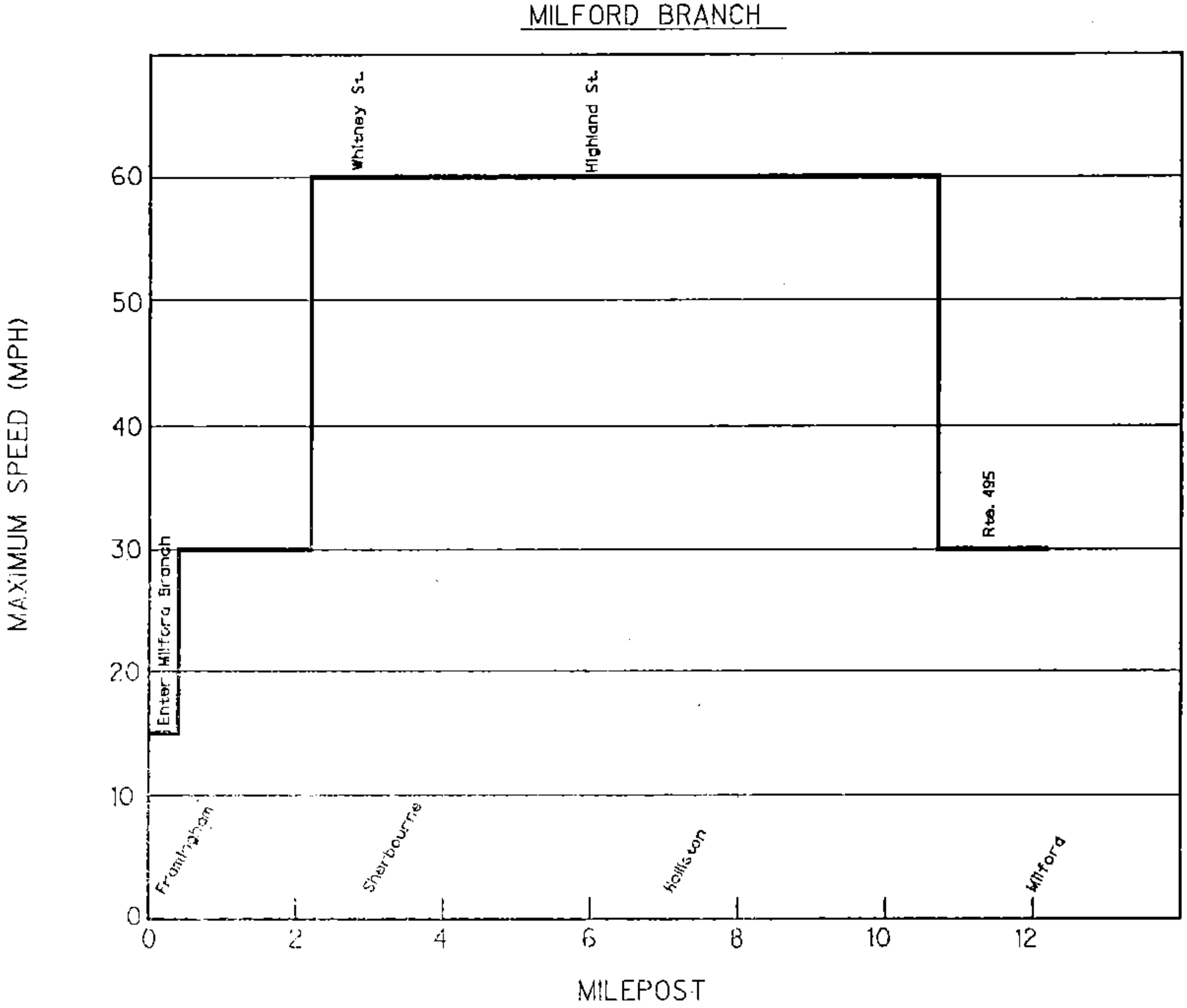
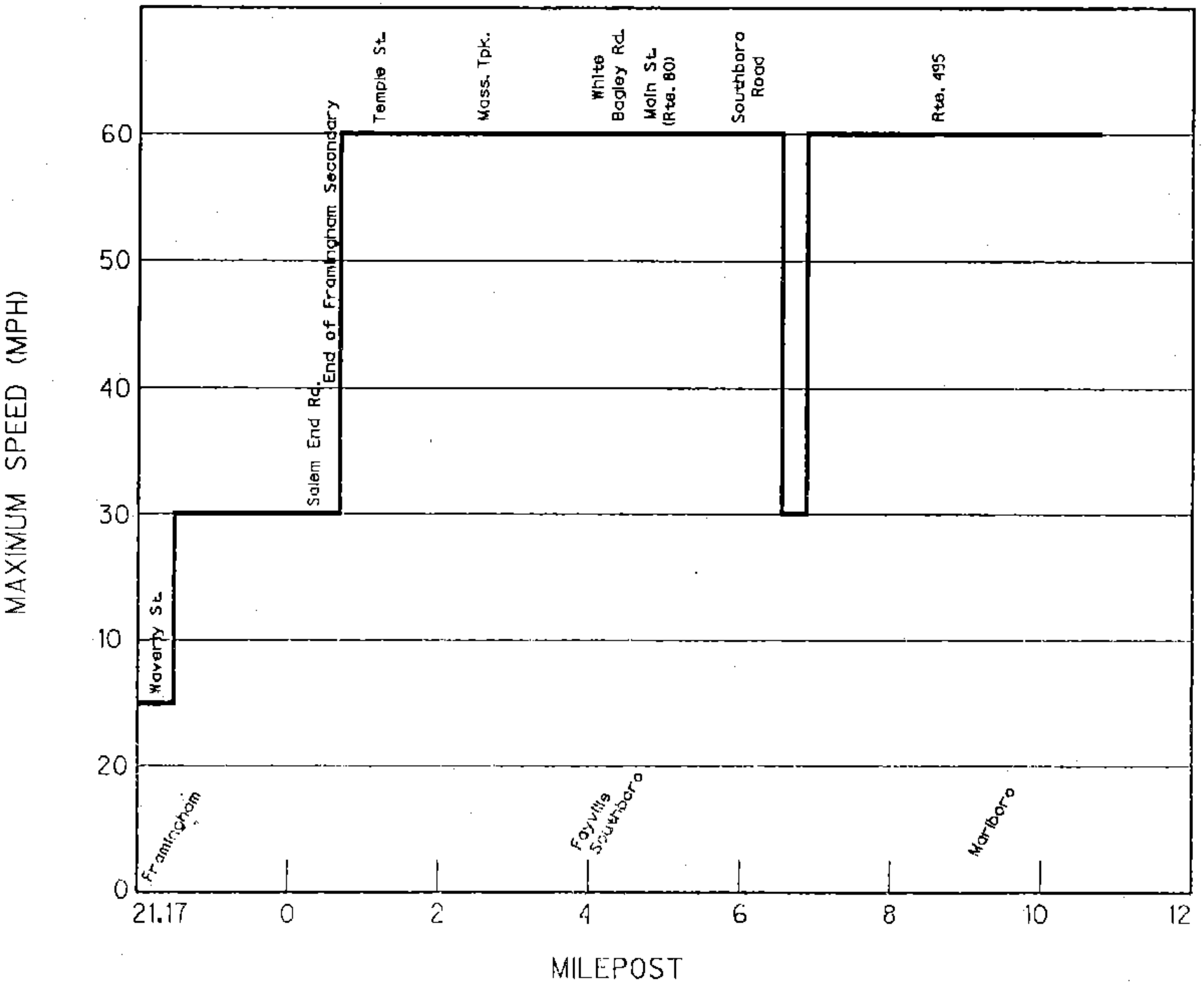


FIGURE 6-3. ASSUMED SPEED PROFILE



MARLBORO BRANCH

TABLE 6-4

TPC GENERATED STATION TO STATION RUN TIMES

		Eastward Times			Westward Times	
Station	**Miles**	**El. Time**	**Inc. Time**		**El. Time**	**Inc. Time**
Worcester	0.00	0.000	0.000		31.023	10.530
N. Grafton	7.88	9.495	9.495	^	20.493	9.419
Westborough	15.36	18.808	9.313	^	11.074	6.626
Ashland	19.88	25.225	6.417	^	4.448	4.448
Framingham	22.88	30.644	5.419	R	0.000	0.000
				E		
Milford	0.00	0.000	0.000	A	22.139	6.103
Holliston	2.72	5.100	5.100	D	16.036	6.764
E. Holliston	7.38	11.721	6.621		9.272	9.272
Framingham	12.30	21.736	10.015	U	0.000	0.000
				P		
Westborough (I-495)	0.00	0.000	0.000	^	21.807	5.985
Main Street	3.06	5.216	5.216	^	15.822	4.634
California Street	5.34	9.557	4.341	^	11.188	5.476
Salem-End	8.26	14.781	5.224	^	5.712	5.712
Framingham	10.39	21.271	6.490		0.000	0.000

Table 6-5

WORCESTER ONLY - ALTERNATIVE 1A

NOTES	SOUTH STN	FRAMINGHAM	ASHLAND	WESTBORO	N.GRAFTON	WORCESTER	SET NO
EXI							
C	05:00 AM	05:42 AM					1F
EXI							
C	05:20 AM	05:55 AM					2F/3F
EXI							
C	06:50 AM	07:30 AM					4F
EXI							
C-DOU							
EXI	06:20 AM	07:05 AM	07:09 AM	07:15 AM	07:25 AM	07:38 AM	5W
C	07:35 AM	08:10 AM					1F
L	08:10 AM	08:55 AM	08:59 AM	09:05 AM	09:15 AM	09:28 AM	1W
L	10:10 AM	10:55 AM	10:59 AM	11:05 AM	11:15 AM	11:28 AM	5W
L	12:10 PM	12:55 PM	12:59 PM	01:05 PM	01:15 PM	01:28 PM	1W
L	02:10 PM	02:55 PM	02:59 PM	03:05 PM	03:15 PM	03:28 PM	5W
EXO	04:10 PM	04:45 PM	04:49 PM	04:55 PM	05:05 PM	05:18 PM	1W
C	04:30 PM	05:10 PM					1F
EXO	04:40 PM	05:15 PM	05:19 PM	05:25 PM	05:35 PM	05:48 PM	4W
C	04:50 PM	05:40 PM					2F
EXO	05:10 PM	05:45 PM	05:49 PM	05:55 PM	06:05 PM	06:18 PM	2W
C-DOU	05:20 PM	06:10 PM					3F
EXO	05:40 PM	06:15 PM	06:19 PM	06:25 PM	06:35 PM	06:48 PM	3W
C-DOU	05:50 PM	06:45 PM					4F
L	06:05 PM	06:50 PM	06:54 PM	07:01 PM	07:10 PM	07:23 PM	5W
L	07:10 PM	07:55 AM	07:59 PM	08:05 PM	08:15 PM	08:28 PM	1W
L	09:30 PM	10:15 PM	10:19 PM	10:25 PM	10:35 PM	10:48 PM	4W
L	11:30 PM	12:15 AM	12:19 AM	12:25 AM	12:35 AM	12:48 AM	1W

WORCESTER	N.GRAFTON	WESTBORO	ASHLAND	FRAMINGHAM	SOUTH STN	SET NO
05:48 AM	05:57 AM	06:06 AM	06:13 AM	06:20 AM	06:55 AM	1W
				06:25 AM	07:10 AM	1F
06:28 AM	06:37 AM	06:46 AM	06:53 AM	07:00 AM	07:35 AM	2W
				07:05 AM	07:55 AM	2F
06:58 AM	07:07 AM	07:16 AM	07:23 AM	07:30 AM	08:05 AM	3W
				07:35 AM	08:25 AM	3F
07:28 AM	07:37 AM	07:46 AM	07:53 AM	08:00 AM	08:35 AM	4W
				08:05 AM	08:50 AM	4F
07:55 AM	08:04 AM	08:13 AM	08:20 AM	08:30 AM	09:05 AM	5W
				08:40 AM	09:30 AM	1F
09:55 AM	10:04 AM	10:13 AM	10:20 AM	10:30 AM	11:15 AM	1W
11:55 AM	12:04 PM	12:13 PM	12:20 PM	12:30 PM	01:15 PM	5W
01:55 PM	02:04 PM	02:13 PM	02:20 PM	02:30 PM	03:15 PM	1W
03:55 PM	04:04 PM	04:13 PM	04:20 PM	04:30 PM	05:15 PM	5W
05:35 PM	05:44 PM	05:53 PM	06:00 PM	06:10 PM	06:55 PM	1W
				05:25 PM	06:15 PM	1F
				06:40 PM	07:25 PM	2F
06:55 PM	07:04 PM	07:13 PM	07:20 PM	07:30 PM	08:10 PM	4W
				07:10 PM	07:50 PM	3F/4F
08:55 PM	09:04 PM	09:13 PM	09:20 PM	09:30 PM	10:10 PM	1W
10:55 PM	11:04 PM	11:13 PM	11:20 PM	11:30 PM	12:15 AM	5W

C=CURRENT SERVICE SUBSTITUTE
EXI=EXPRESS INBOUND (FRAMINGHAM/BACK BAY)
EXO=EXPRESS OUTBOUND
[illegible]

Table 6-6

	WORCESTER	N.GRAFTON	WESTBORO	ASHLAND	MILFORD	HOLLISTON	E.HOLLISTO	FRAMINGHAM	SOUTH STN	SET NO
	05:48 AM	05:57 AM	06:06 AM	06:13 AM				06:20 AM	06:55 AM	1W
L					06:10 AM	06:15 AM	06:23 AM	06:35 AM	07:20 AM	1M
	06:28 AM	06:37 AM	06:46 AM	06:53 AM				07:00 AM	07:35 AM	2W
L					06:45 AM	06:50 AM	06:58 AM	07:10 AM	07:50 AM	2M
	06:58 AM	07:07 AM	07:16 AM	07:23 AM				07:30 AM	08:05 AM	3W
L					07:15 AM	07:20 AM	07:20 AM	07:40 AM	08:25 AM	3M
	07:28 AM	07:37 AM	07:46 AM	07:53 AM				08:00 AM	08:35 AM	4W
L					07:45 AM	07:50 AM	07:50 AM	08:10 AM	08:55 AM	4M
	07:55 AM	08:04 AM	08:13 AM	08:20 AM				08:30 AM	09:05 AM	5W
SH					10:00 AM	10:05 AM	10:13 AM	10:25 AM		1M
	09:55 AM	10:04 AM	10:13 AM	10:20 AM				10:30 AM	11:15 AM	1W
SH					12:00 PM	12:05 PM	12:13 PM	12:25 PM		1M
	11:55 AM	12:04 PM	12:13 PM	12:20 PM				12:30 PM	01:15 PM	5W
SH					02:00 PM	02:05 PM	02:13 PM	02:25 PM		1M
	01:55 PM	02:04 PM	02:13 PM	02:20 PM				02:30 PM	03:15 PM	1W
EXI					04:00 PM	04:05 PM	04:13 PM	04:25 PM	05:00 PM	1M
	03:55 PM	04:04 PM	04:13 PM	04:20 PM				04:30 PM	05:15 PM	5W
	05:36 PM	05:44 PM	05:53 PM	06:00 PM				06:10 AM	05:55 PM	1W
SH					07:05 PM	07:10 PM	07:18 PM	07:30 PM		1M
	07:00 PM	07:09 PM	07:18 PM	07:25 PM				07:35 PM	08:15 PM	4W
SH					09:00 PM	09:05 PM	09:13 PM	09:25 PM		1M
	08:55 PM	09:04 PM	09:13 PM	09:20 PM				09:30 PM	10:10 PM	1W
SH					11:00 PM	11:05 PM	11:13 PM	11:25 PM		1M
	10:55 PM	11:04 PM	11:13 PM	11:20 PM				11:30 PM	12:15 AM	5W

NOTES APPLY AS THOUGH ROWS WERE CONTINUOUS

C=CURRENT SERVICE SUBSTITUTE
L=LOCAL SERVICE
EXO=EXPRESS OUTBOUND (BACK BAY/FRAMINGHAM)
EXI=EXPRESS INBOUND
DOU=DOUBLES OUT OR IN; SH = MILFORD SHUTTLE

Table 6-6

WORCESTER/MILFORD - ALTERNATIVE 2B - MILFORD OFF PEAK SHUTTLE

NOTES	SOUTH STN	FRAMINGHAM	E.HOLLISTO	HOLLISTON	MILFORD	ASHLAND	WESTBORO	N.GRAFTON	WORCESTER	SET NO
EXI	06:20 AM	07:05 AM				07:09 AM	07:16 AM	07:25 AM	07:38 AM	5W
L	08:10 AM	08:55 AM				08:59 AM	09:06 AM	09:15 AM	09:28 AM	1W
SH	08:40 AM	09:25 AM	09:28 AM	09:34 AM	09:50 AM					1M
L	10:10 AM	10:55 AM				10:59 AM	11:06 AM	11:15 AM	11:28 AM	5W
SH		11:00 AM	11:03 AM	11:09 AM	11:25 AM					1M
L	12:10 PM	12:55 PM				12:59 PM	01:06 PM	01:15 PM	01:28 PM	1W
SH		01:00 PM	01:03 PM	01:09 PM	01:25 PM					1M
L	02:10 PM	02:55 PM				02:59 PM	03:06 PM	03:15 PM	03:28 PM	5W
SH		03:00 PM	03:03 PM	03:09 PM	03:25 PM					1M
EXO	04:10 PM	04:45 PM				04:49 PM	04:56 PM	05:05 PM	05:18 PM	1W
C	04:15 PM	05:00 PM	05:03 PM	05:09 PM	05:25 PM					4M
EXO	04:40 PM	05:15 PM				05:19 PM	05:26 PM	05:35 PM	05:48 PM	4W
C-DOU	04:45 PM	05:30 PM	05:33 PM	05:40 PM	05:55 PM					3M
EXO	05:10 PM	05:45 PM				05:49 PM	05:56 PM	06:05 PM	06:18 PM	2W
C	05:15 PM	06:00 PM	06:11 PM	06:17 PM	06:25 PM					2M
EXO	05:40 PM	06:15 PM				06:19 PM	06:26 PM	06:35 PM	06:48 PM	3W
C	05:45 PM	06:30 PM	06:41 PM	06:47 PM	06:55 PM					1M
L	06:05 PM	06:50 PM				06:54 PM	07:01 PM	07:10 PM	07:23 PM	5W
L	07:10 PM	07:55 PM				07:59 PM	08:06 PM	08:15 PM	08:28 PM	1W
SH		08:00 PM	08:03 PM	08:09 PM	08:25 PM					1M
L	09:30 PM	10:15 PM				10:19 PM	10:26 PM	10:35 PM	10:48 PM	4W
SH		10:20 PM	10:23 PM	10:29 PM	10:45 PM					1M
L	11:30 PM	12:15 AM				12:19 AM	12:26 AM	12:35 AM	12:48 AM	1W
SH		12:20 AM	12:23 AM	12:29 AM	12:45 AM					1M

Table 6-7

MARLBORO/MILFORD - ALTERNATIVE 3B - MILFORD OFFPEAK SHUTTLE

NOTES	SOUTH STN	FRAMINGHAM	MILFORD	MARLBORO	MARLBORO	MILFORD	FRAMINGHAM	SOUTH STN	SET
L MB					05:57 AM	-	06:20 AM	07:05 AM	1
E MF					-	06:10 AM	06:35 AM	07:10 AM	2
E MB DOU					06:32 AM	-	06:55 AM	07:30 AM	3
L MF					-	06:35 AM	07:00 AM	07:50 AM	4
E MF DOU					-	07:00 AM	07:25 AM	08:00 AM	5
L MB	05:35 AM	06:15 AM		06:50 AM	07:07 AM	-	07:30 AM	08:20 AM	6
E MB DOU					07:32 AM	-	07:55 AM	08:30 AM	7
L MF					-	07:35 AM	08:00 AM	08:45 AM	8
E MF DOU						08:00 AM	08:25 AM	09:00 AM	9
L MB	06:35 AM	07:15 AM		07:50 AM	08:07 AM	-	08:30 AM	09:20 AM	10
C	08:15 AM	09:00 AM		09:25 AM	09:45 AM		10:10 AM	10:55 AM	3
SH	08:20 AM	09:05 AM	09:30 AM			09:40 AM	10:05 AM		5
C	10:15 AM	11:00 AM		11:25 AM	11:45 AM		12:10 PM	12:55 PM	10
SH		11:05 AM	11:30 AM			11:40 AM	12:05 PM		6
C	12:15 PM	01:00 PM		01:25 PM	01:45 PM		02:10 PM	02:55 PM	3
SH		01:05 PM	01:30 PM			01:40 PM	02:05 PM		5
C	01:50 PM	02:35 PM		03:00 PM	03:15 PM		03:40 PM	04:20 PM	10
SH		02:40 PM	03:05 PM			03:20 PM	03:45 PM		5
L							04:45 PM	05:30 PM	5
E MF	04:30 PM	05:05 PM	05:30 PM						2
L MB DOU	04:35 PM	05:20 PM		05:45 PM					3
E MB	05:00 PM	05:35 PM		06:00 PM	06:10 PM		06:35 PM	07:10 PM	6
L MF DOU	05:05 PM	05:50 PM	06:15 PM						4
E MF	05:30 PM	06:05 PM	06:30 PM						10
L MB DOU	05:35 PM	06:20 PM		06:45 PM					1
E MB	06:00 PM	06:35 PM		07:00 PM					5
L MF DOU	06:05 PM	06:50 PM	07:15 PM						7
E MF	06:30 PM	07:05 PM	07:30 PM			08:00 PM	08:20 PM		8
L MB	06:35 PM	07:20 PM		07:45 PM	08:00 PM		08:25 PM	09:10 PM	9
C	08:35 PM	09:20 PM		09:45 PM	10:05 PM		10:30 PM	11:15 PM	0
SH		09:25 PM	09:50 PM			10:00 PM	10:25 PM		8
C	10:35 PM	11:20 PM		11:45 PM	12:05 AM		12:30 AM	01:15 AM	9
SH		11:25 PM	11:50 PM			12:00 AM	12:25 AM		0
DH		12:35 AM	01:00 AM						8

L=LOCAL TRAIN
E=EXPRESS TRAIN
MF=MILFORD SERVICE; SH = SHUTTLE
MB=MARLBORO SERVICE
DOU=TRAIN WHICH DOUBLES OUT OR IN
C=CURRENT SERVICE SUBSTITUTE
DH=DEADHEAD IN OFF PEAK DIRECTION

MARLBORO EXPRESS SERVICE - ALTERNATIVE 4A

Table 6-8

NOTES	SOUTH STN	FRAMINGHAM	SALEM-END	CALIFORNIA	MAIN STREE	MARLBORO	MARLBORO	MAIN STREE	CALIFORNIA	SALEM-END	FRAMINDHA	SOUTH STN	SET
EXI-DHO							06:00 AM	06:06 AM	06:11 AM	06:16 AM	06:23 AM	06:58 AM	1M
C	06:00 AM	06:42 AM									06:25 AM	07:10 AM	1F
EXI-DOU							06:30 AM	06:36 AM	06:41 AM	06:46 AM	06:53 AM	07:28 AM	2M
C	06:20 AM	06:55 AM									07:05 AM	07:55 AM	2F,3F
EXI-DHO							07:00 AM	07:06 AM	07:11 AM	07:16 AM	07:23 AM	07:58 AM	3M
C-DOU											07:35 AM	08:20 AM	3F
EXI-DOU							07:30 AM	07:36 AM	07:41 AM	07:46 AM	07:53 AM	08:28 AM	4M
EXI	06:40 AM	07:15 AM	07:21 AM	07:28 AM	07:34 AM	07:40 AM	08:00 AM	08:06 AM	08:11 AM	08:16 AM	08:23 AM	08:58 AM	6M
C	06:50 AM	07:30 AM									08:00 AM	08:45 AM	4F
C	07:35 AM	08:10 AM									08:30 AM	09:20 AM	1F
L	08:10 AM	08:55 AM	09:01 AM	09:08 AM	09:14 AM	09:20 AM	09:30 AM	09:36 AM	09:41 AM	09:46 AM	09:53 AM	10:43 AM	2M
L	10:10 AM	10:55 AM	11:01 AM	11:08 AM	11:14 AM	11:20 AM	11:30 AM	11:36 AM	11:41 AM	11:46 AM	11:53 AM	12:43 PM	6M
L	12:10 PM	12:55 PM	01:01 PM	01:08 PM	01:14 PM	01:20 PM	01:30 PM	01:36 PM	01:41 PM	01:46 PM	01:53 PM	02:43 PM	2M
L	02:10 PM	02:55 PM	03:01 PM	03:08 PM	03:14 PM	03:20 PM	03:30 PM	03:36 PM	03:41 PM	03:46 PM	03:53 PM	04:43 PM	6M
EXO-DOU	04:10 PM	04:45 PM	04:51 PM	04:58 PM	05:04 PM	05:10 PM							2M
C	04:30 PM	05:12 PM									05:30 PM	06:15 PM	1F
EXO-DHI	04:40 PM	05:15 PM	05:21 PM	05:28 PM	05:34 PM	05:40 PM							1M
C	05:15 PM	06:05 PM									06:30 PM	07:15 PM	2F
EXO-DOU	05:10 PM	05:45 PM	05:51 PM	05:58 PM	06:04 PM	06:10 PM							3M
C-DOU	05:45 PM	06:35 PM											3F
EXO-DHI	05:40 PM	06:15 PM	06:21 PM	06:28 PM	06:34 PM	06:40 PM							4M
C	06:05 PM	06:55 PM									07:10 PM	08:00 PM	3F,4F
L	07:00 PM	07:45 PM	07:51 PM	07:58 PM	08:04 PM	08:10 PM	08:20 PM	08:26 PM	08:31 PM	08:36 PM	08:43 PM	09:18 PM	6M
L	09:30 PM	10:15 PM	10:21 PM	10:28 PM	10:34 PM	10:40 PM	10:50 PM	10:56 PM	11:01 PM	11:06 PM	11:13 PM	11:48 PM	6M
L	12:00 AM	12:45 AM	12:51 AM	12:58 AM	01:04 AM	01:10 AM	01:20 AM	01:26 AM	01:31 AM	01:36 AM	01:43 AM	02:18 AM	6M

L=LOCAL SERVICE
C=CURRENT SCHEDULE SUBSTITUTE
EXO=EXPRESS OUTBOUND (BACK BAY/FRAMINGHAM)
EXI=EXPRESS INBOUND
DHO=DEADHEAD OUT
DHI=DEADHEAD IN
DOU=TRAIN WHICH DOUBLES OUT OR IN

TABLE 6-9

ROLLING STOCK REQUIREMENTS FOR NEW RAIL SERVICE
PLUS ADJUSTMENTS TO BASELINE FRAMINGHAM LOCAL SERVICE

	New Service Requirements[1]				Framingham Service Adjustments[2]				Net Additional Requirements[3]			
Equipment Type	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Peak Train sets	5	9	10	5	0	-4	-4	0	5	5	6	5
Locomotives* (incl. spares)	6	11	12	6	0	-5	-5	0	6	6	7	6
Control Cars* (incl. spares)	6	11	12	6	0	-5	-5	0	6	6	7	6
Trailer Cars* (incl. spares)	14	38	36	19	-5	-26	-26	-5	9	12	10	14

---

* Spares estimated at 14.8% for locomotives and control cars, 11.7% for trailer cars.

[1] New service requirements include rolling stock requirements for only those services which go beyond Framingham.

[2] Framingham service adjustments arise from predicted shifts to new express services or the substitution of a new service (e.g. to Milford) which affords service to new travel markets while duplicating current service to all existing stations.

[3] Net additional requirements are the resulting rolling stock requirements when reductions in Framingham trainset requirements are offset against the new service rolling stock requirements.

CHAPTER 7
ENVIRONMENTAL ISSUES

7.1 WATER RESOURCES/BIOLOGICAL RESOURCES

This section inventories the wetland and biological resources associated with the proposed extensions, discuss these resources in greater detail for the preferred station sites, and outlines the regulatory framework applicable to the proposed project.

Natural Resources at Station Sites

The natural resources associated with the proposed station sites are summarized in Table 7-1, according to their location along each of the extensions. Each station location was evaluated with respect to wetland, floodplain and aquifer areas, water quality standards, and the presence of rare or endangered wetland wildlife species. The following procedures were utilized to evaluate each of these parameters.

- Wetlands. Each station site under consideration was inspected in the field to determine whether or not wetland resource areas were present. Wetland boundaries were approximated based primarily on vegetative criteria. Where appropriate, the hydrologic setting and soil characteristics of identified wetland areas were also recorded. Table 7-1 identifies those station sites which contain or are located within 100 feet of wetland resource areas.

- Floodplains. Floodplain areas (e.g., the 100-year Flood Zone) were identified on designated station sites based on review of Federal Emergency Management Agency (FEMA) maps. Table 7-1 lists those sites which contain floodplains as mapped by FEMA.

- Aquifer Areas. Station site location within a known aquifer area was determined based on interviews with local officials and review of local aquifer or water supply protection maps. Those towns having local aquifer protection bylaws are indicated in Table 7-1 according to station locations.

- Water Quality Standards. Standards for the water quality of the major drainage basins in the Commonwealth have been determined by the Department of Environmental Protection (DEP). Table 7-1 lists the designated water quality standards applicable to each station site based on its drainage basin location.

- Rare or Endangered Wetland and Wildlife Species. The existence of known rare or endangered wetland wildlife species within, or in proximity to, each station site was determined based on review of the Atlas of Estimated Habitats of State-Listed Rare Wetlands Wildlife (Massachusetts Natural Heritage and Endangered Species Program, 1989).

Wetlands and Floodplains at Preferred Sites

Portions of the proposed rail extensions and associated station sites are located in proximity to a variety of wetland resource areas. These areas include marshes, swamps, water bodies/waterways, and lands subject to flooding. Figures F-1 through F-17 in Appendix F approximate these resource areas in relation to the proposed rail extensions and station sites, based on the National Wetlands Inventory maps prepared by the U.S. Fish and Wildlife Service for the project areas. A legend explaining the abbreviated wetland community classifications used in each of these Figures is shown on Figure F-1.

Figures 4-1 through 4-20 for preferred sites and Figures Aa-1 through Aa-25 for alternate sites provide a better approximation of the extent of wetland areas where identified in the field for each station location. The sites presented in Chapter 4 have been designated as "preferred" based on location, size, community, access, and cost considerations. The following sections of this report summarize the wetland and floodplain considerations associated with these preferred sites for each extension.

WORCESTER EXTENSION

Ashland - Howe Street. As shown on Figure 4-2, the Sudbury River flows north of the existing parking lot. Vegetated wetlands associated with the River are not extensive adjacent to the area currently designated for commuter parking. However, wetland areas located in the northeasterly portions of the site could pose a constraint to parking lot expansion. A review shows that the 100-year floodplain associated with the Sudbury River encroaches upon the northern sections of the site.

Westborough - Fruit Street. This site is also located in direct proximity to the Sudbury River. Two distinct wetland areas were identified within 100 feet of this station location. As shown on Figure 4-4, the first area is an intermittent stream at the western edge of the site, which drains to the River, with an associated bordering vegetated wetland. The second area to the east of the site is more extensive, and consists of a wooded swamp associated with an unnamed stream which is also tributary to the Sudbury River. It is possible that the presence of these wetland areas would pose a constraint to constructing a 1000 parking space commuter parking lot on this site. A review of FEMA maps indicates that the 100-year floodplain associated with the Sudbury River is mapped extensively within the boundaries of this preferred site.

Grafton - Pine Street. This site contains an intermittent stream and pond which drain in a southerly direction, forming the headwaters of Axtell Brook in the Blackstone River watershed. The approximate boundary of wooded swamp associated with this system is approximated on Figure 4-6. As currently proposed, construction of the platform and parking lot would fall within 100 feet of this wetland area. The FEMA maps for the Town of Grafton do not identify the 100-year floodplain in the vicinity of the Pine Street site.

Worcester - Amtrak Station. The existing Amtrak station consists entirely of upland area. In addition, it is not located within 100 feet of a wetland resource area. No 100-year floodplain areas are indicated on the FEMA maps for the City of Worcester in the vicinity of the Amtrak Station.

MILFORD EXTENSION

Holliston - Lowland Street. This preferred site is undeveloped and occupied by an open field. As shown on Figure 4-10, the southwestern border of the site would appear to coincide with the outermost boundary of bordering vegetated wetlands based on paced measurements to known ground features. At the very least, the site is located within the 100-foot wetland buffer zone. The FEMA maps for the Town of Holliston do not show any portion of the site within the 100-year floodplain.

Milford - Webber's Lumber Yard. The majority of this preferred site is occupied by the Webber Lumber Yard, whereas the remaining portion of the property is undeveloped. It would appear that bordering vegetated wetlands are restricted to the northeasternmost portion of the site, as shown on Figure 4-12. This site is not included in the 100-year floodplain as shown on the FEMA maps for Milford.

MARLBOROUGH EXTENSION

Framingham - Salem End Road. This site, currently utilized by Salem State College for student parking, does not contain any wetland resource areas. It is possible, however, that portions of the site are located within 100 feet of Baiting Brook which flows southeast of the site. The FEMA maps for the City of Framingham do not designate any portion of this site as part of the 100-year floodplain.

Framingham - California Avenue. This preferred site is located in an industrial park, and is partially occupied by a Westinghouse facility, consisting of a building and parking area. The water table is at or near the ground surface on the remaining portion of the property, perhaps due to past grading activities. As approximated on Figure 4.16, a marsh is located in the east central portion of the property. The location of this wetland with respect to the site boundaries is likely to restrict the extent of site development. This site is not included in the 100-year floodplain as shown on the FEMA maps for Framingham.

Southborough - Southborough Center. This preferred site is located at Southborough Center near Route 30. Wetlands in the form of a culverted stream are present on the station site, as depicted in Figure 4-18. The location of this wetland with respect to the site boundaries is likely to restrict the extent of site development. This site is not included in the 100 year floodplain as shown on the FEMA maps for Southborough.

Southborough - Northboro Road. This site is currently vacant and is crossed by several large power lines. Wetland resources are limited to two small marsh areas associated with trackside drainage ditches. It is likely that the channels are hydrologically connected to a drainage system which flows southeasterly of the site and adjacent to the Hultman Aqueduct. The approximate boundaries of these areas are shown on Figure 4-20. It does not appear that the presence of these wetland areas will pose a severe constraint to site development. The FEMA maps for the Town of Southborough do not show any portion of the site within the 100-year floodplain.

Water Quality and Biological Resources

The three rail line extensions and accompanying preferred sites are located within the Concord River (Sudbury/Assabet Rivers), the Blackstone River (Middle River) and the Charles River drainage basins. As noted in Table 7-1, these waterways are designated either Class "A" or Class "B" waterways, in accordance with the DEP - Division of Water Pollution Control ("DWPC") classification scheme. These categories are determined by the most sensitive uses these waterways are intended to provide or protect. According to the Massachusetts Surface Water Quality Standards [310 CMR 4.04(3)], these classifications also include anti-degradation provisions for low-flow waters, and are defined as follows:

> "Class A - Waters assigned to this class are designated for use as a source of public [drinking] water supply".
>
> "Class B - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife, and for primary and secondary contact recreation".

Table 7-1 denotes the specific designated uses for those waterways located either immediately adjacent to or within the drainage area of the sites. The following sections of this report discuss the water quality and biological resources of the preferred sites and associated rail lines.

WORCESTER EXTENSION

The preferred station sites in Ashland (Howe Street) and Westborough (Fruit Street) are located in close proximity to the Sudbury River. Designated uses of the surface waters in the River are seasonal cold water fisheries (e.g, brown and brook trout) and primary/secondary contact recreation, including swimming and boating.

The Pine Street (Grafton) and Amtrak Station (Worcester) preferred sites are located within the Blackstone River drainage basin, but not immediately adjacent to the River. In both cases, surface runoff from the sites flows overland a considerable distance prior to reaching the Blackstone River. The designated uses of the River, its tributaries and associated wetlands are warmwater fisheries (e.g., small and large mouth bass) and primary/secondary contact recreation.

In order to preserve the quality and intended uses of these surface waters, the project should be designed to prevent adverse water quality impacts. This goal can be achieved by developing a final project design which provides controls on the quality of runoff from station sites and the upgraded rail lines, addresses rail line maintenance (e.g., use of pesticides) and prevents erosion/sedimentation.

With respect to wildlife habitat, it is expected that the area encompassed by the Worcester Extension supports a population representative of the region and its relatively urbanized environment. According to the 1989 Atlas of Estimated Habitats of State-Listed Rare Wetlands Wildlife (Massachusetts Natural Heritage Program, 1989), no endangered or threatened species, nor any ecologically significant natural communities, occur along the proposed extension or within any of the preferred station sites. It should be noted, however, that the proposed Route 85 site in Southborough (non-preferred) is located immediately adjacent to a designated habitat for rare/endangered wetlands wildlife.

MILFORD EXTENSION

Along the Milford Extension, the Lowland Street (Holliston) and Webber's Lumber Yard (Milford) preferred sites are located within the Charles River drainage basin. However, these sites are not situated in close proximity to the River; runoff from these areas first enters tributaries of the River. The designated uses of the surface waters of this section of the Charles River, its tributaries and associated wetlands includes preservation/protection of aquatic life, seasonal warmwater/coldwater fisheries and primary/secondary contact recreation. As noted previously, the final design and operation plan for commuter parking lots/rail line extension should include measures to prevent deterioration of these standards.

Regarding wildlife habitat, it is expected that the general project area supports a population typical of the region. However, inspection of the Atlas of Estimated Habitats of State-Listed Rare Wetlands Wildlife, indicates that the segment of the proposed extension north of Holliston Center, including the non-preferred Parker Snacks site, as well as Cedar Swamp Pond (Milford Center), are identified habitats for rare/endangered wetlands wildlife. The remaining station sites and rail line do not support any threatened species, nor any ecologically significant natural communities.

MARLBOROUGH EXTENSION

The Marlborough Extension and identified preferred sites (Salem End Road, California Avenue - Framingham, Northboro Road -Southborough) are located within the Assabet River (Concord River) drainage basin. These sites are situated in relatively close proximity to the Sudbury Reservoirs which are designated as Class "A" - public drinking water supplies.

In order to preserve the designated classification of these surface waters, the project should not create adverse impacts to the water quality of these water bodies/waterways. As noted with the Worcester and Milford Extensions, this includes the development of a final project design which provides controls on the quality of runoff from station sites/upgraded rail line, addresses rail line maintenance (e.g., use of pesticides) and prevents erosion/sedimentation.

With respect to wildlife habitat, it is expected that the project area supports a regionally representative wildlife population. No habitats for rare/endangered wetland wildlife are identified along the rail line extension or within the preferred station sites, according to the Atlas of Estimated Habitats of State-Listed Rare Wetlands Wildlife.

Applicable Regulatory Framework

As described in previous sections of this chapter, sensitive environmental receptors, particularly wetland resource areas, are present at particular station locations, and/or along the proposed rail extensions.

At the Federal level, the U.S. Army Corps of Engineers has classified "the repair, rehabilitation, or replacement of any previously authorized...structure or fill..." as a Nationwide Permit (33 CFR Part 330.5). This status allows work under certain thresholds in wetlands and waterways of the United States without the filing of an individual permit. Similarly, the Massachusetts Wetlands Protection Act (MGL Ch.131, s.40) and accompanying regulations (310 CMR 10.00), provides for the "maintenance, repair and improvement of structures, including bridges and culverts...". Under this provision [310 CMR 10.53 (3)], these projects may be permitted by the issuing authority if the interests identified in the Act (e.g., wildlife habitat, public water supply) are not adversely affected.

While the rehabilitation of the existing rail line and accompanying drainage improvements may be permitted under existing state and federal standards, any new construction (e.g., stations and boarding platforms) will be subject to local, state and federal standards. The laws which potentially apply to work in or near wetland and other resource areas are summarized in Table 7-2. The regulations referenced in this table are discussed in greater detail below.

WETLANDS

U.S. Army Corps of Engineers ("ACOE"). Protection for wetlands at the Federal level is found principally in Section 404 of the Clean Water Act, as amended (1977). Under Section 404, a permit is required from the ACOE for the placement of dredged or fill material in waters of the United States. In addition, under Section 10 of the Rivers and Harbors Act of 1899, ACOE authorization is required for the placement of structures in navigable waterways.

Therefore, any activity associated with the construction of a new station site which also alters wetland areas requires a permit from the ACOE. With the exception of Pine Street and the Amtrak Station (Worcester Extension), Lowland Street (Milford Extension) and Salem End Road (Marlborough Extension) sites, this permit requirement could potentially apply to the remaining preferred sites.

Massachusetts Wetlands Protection Act (MGL Ch.131, s.40). Under the Act, freshwater wetlands are defined as wet meadows, marshes, swamps, and bogs which border water bodies; the land under any water bodies/waterways; the bank(s) of any water bodies; and lands subject to flooding. Permits are required for any activity that involves filling, dredging, removing or altering any bank, marsh, meadow, swamp, bog, creek, river, stream, pond or lake. Permits are also required for any of these activities within 100 feet of these areas and on lands subject to flooding. Municipal Conservation Commissions are empowered to enforce the Act on a local basis.

In considering an application (e.g., Notice of Intent) for a permit (e.g., Order of Conditions), the issuing authority must evaluate the impact of the proposed project on public and private water supply, groundwater supply, flood control, storm damage prevention, prevention of pollution, and protection of wildlife habitat, and protection of fisheries.

Due to the presence of wetlands either on-site or within 100 feet of station sites, the Act will apply to activities associated with the construction of boarding platforms and commuter parking lots on all of the preferred sites, except for the Amtrak Station (Worcester Extension).

As noted earlier, the improvement of runoff quality from parking facilities located in close proximity to waterways/wetlands should be a design consideration under applicable water quality standards. In addition, relevant wetland protection laws (especially MGL ch.131, s.40) require consideration of both runoff quality and quantity to prevent adverse impacts on wetland functions, including prevention of pollution and flood control. Mitigation measures which could be implemented to prevent these impacts include upland detention

EIS is deemed necessary, project alternatives must b evaluated, in addition to consideration of the National Historic Preservation Act and federal policies regarding floodplains and wetlands (Executive Orders 11988 and 11990, respectively).

- U.S. Department of Transportation Act of 1966. This statute is applicable to any project which receives funding the from the U.S. Department of Transportation. Specifically, it is required that such projects afford protection to significant natural and historic resources.

7.6 TRAFFIC

This section of the study report presents an evaluation of traffic related issues for each of the following preferred station locations:

- Ashland - Howe Street
- Westborough - Fruit Street
- Grafton - Pine Street
- Worcester - Amtrak Station
- Holliston - Lowland Street
- Milford - Webber's Lumber Yard
- Framingham - Salem End Road
- Framingham - California Avenue
- Southborough - Southborough Center
- Southborough - Northborough Road

These sites, previously evaluated in Section 4.3, are qualitatively assessed in terms of the existing roadway network serving the station, identification of critical locations, the anticipated daily ridership, roadway capacity and where available, traffic volumes and planned roadway improvements.

Ridership projections are discussed by community under each rail alternative for all of the preferred station locations. The projections, as shown in the following Table, are for the design year 2010 and were developed by the Central Transportation Planning Staff (CTPS). However, minor assignment modifications were made to the ridership projections, based on an evaluation of Community Districts to the existing roadway network serving each station.

DAILY INBOUND PERSON-TRIPS BY COMMUNITY, YEAR 2010

Community	Rail Alt. 1 (Worcester)	Rail Alt. 2 (Worc/Milford)	Rail Alt. 3 (Marl/Milford)	Rail Alt. 4 (Marlborough)
Ashland	170	170	---	---
Auburn	50	40	---	---
Berlin	---	---	20	30
Boylston	20	20	---	---
Charlton	20	20	---	---
Framingham	940	940	1,780	1,800
Grafton	30	30	---	---
Holliston	270	260	290	270
Hopkinton	190	190	140	180
Hudson	---	---	50	90
Marlborough	290	290	280	330
Millbury	20	20	---	---
Milford	---	150	150	---
Millis	---	310	320	---
Northborough	100	100	80	90
Oxford	50	50	---	---
Sherborn	290	290	280	290
Shrewsbury	120	130	---	---
Southborough	190	190	190	190
Spencer	40	40	---	---
Sudbury	---	---	410	420
Sutton	30	30	---	---
Upton	30	30	30	---
Westborough	210	220	210	210
West Boylston	10	10	---	---
Worcester	710	710	---	---
Total	3,780	4,240	4,230	3,900

Source: "Town of origin and mode of access for daily person-trips," Worcester/Marlborough/Milford Commuter Rail Study, CTPS, October 16, 1989.

Evaluation of Preferred Station Locations

WORCESTER EXTENSION

Ashland - Howe Street. This station is located on Howe Street, approximately 700 feet south of the Cordaville Road/Howe Street intersection and approximately one-half mile east of the Southborough/Ashland town line. This station will primarily serve the communities of Ashland, Hopkinton, Southborough and Holliston.

Roadway Network

Howe Street is a local roadway that travels south from Cordaville Road through Hopkinton State Park and continues as Wilson Street in Hopkinton. Wilson Street intersects Route 135 approximately three miles from the proposed station. Howe Street is currently closed to through traffic due to the reconstruction of the bridge over the railroad.
Cordaville Road is an arterial roadway with one travel lane in each direction. To the west it continues as Southville Road in Southborough. Southville Road forms a four-way signalized intersection with Route 85 approximately 1.5 miles from the intersection of Cordaville Road/Howe Street. Route 85 is a north-south roadway that travels to Southborough Center to the north and to Hopkinton Center to the south. To the east, Cordaville Road intersects Pleasant Street, which continues into Ashland Center approximately 1.5 miles from the Cordaville Road/ Howe Street intersection.

Access from Holliston is via the several combinations of minor arterial roadways which link Holliston, Hopkinton and Ashland. The most direct route from Holliston to the proposed Howe Street station is via Mill Street in Holliston, which continues as Clinton Street in Hopkinton. Clinton Street terminates at Route 135. Cross Street intersects Route 135 just east of the Route 135/Clinton Street intersection and continues northerly into Ashland where it intersects Howe Street.

In conclusion, local access from the communities of Ashland, Hopkinton, Holliston and Southborough, all of which this station would serve, is excellent.

Regional access to the station is provided via the Route 9/Route 85 interchange located approximately 3.4 miles from the proposed site. Route 9 forms interchanges with the Massachusetts Turnpike and I-495, 2.5 miles to the east and 2.0 miles to the west, respectively. However, it is not anticipated that the riders utilizing the Howe Street station would use the regional highway system. The proposed station will most likely serve immediate communities rather than the regional area.

The critical locations of the roadway network serving the station are the signalized intersection of Route 85/Southville Road and the unsignalized intersection of Cordaville Road/High Street/ Pleasant Street.

from Fruit Street. However, the intersection of Fruit Street with the I-495 southbound ramps will require left-turn movements.

The critical locations of the roadway network serving the station are the unsignalized intersections as listed below:

- Flanders Road/Connector Road
- Computer Drive/Route 9 westbound ramps
- Research Drive/Route 9 eastbound ramps

Ridership Projection

The projected daily ridership at the Fruit Street station for the year 2010 is approximately 870 and 850 inbound person-trips for Rail Alternatives 1 and 2, respectively. The estimated ridership by community for each alternative is as follows:

	2010 Daily Inbound Person Trips	
	Rail Alt. 1 (Worcester)	Rail Alt. 2 (Worcester/Milford)
Marlborough	290	290
Southborough	130	130
Northborough	100	100
Westborough	170	180
Shrewsbury	100	100
Upton	30	--
Hopkinton	50	50
Total	870	850

Traffic Impacts and Recommendations

As Flanders Road west of Connector Road is a residential area, travel to the station via Route 9/Route 30 to Flanders Road should be avoided. Thus, it is important that the Route 9 ramps at Computer and Research Drives be improved. The improvements as recommended should increase capacity and encourage commuters to utilize the Connector Road/Flanders Road route.

Grafton - Pine Street. This site in the northwestern part of Grafton on the west side of Pine Street. This station will primarily serve the communities of Grafton, Oxford, Charlton, Shrewsbury and Westborough.

Roadway Network

Pine Street is a local roadway that forms an unsignalized intersection with Route 30 approximately 300 feet south of the proposed station. To the north, Pine Street continues as Green Street in Shrewsbury. Approximately 2.5 miles from the site, Green Street intersects Route 20 at unsignalized intersection. Pine Street/Green Street is a narrow roadway with a curving alignment. It serves typically residential abutters.

Route 30 (Westborough Road) is a two-lane state highway that travels east-west. It forms a T-intersection with Route 140 approximately 2 miles west of the Route 30/Pine Street intersection. To the east, Route 30 connects the communities of Grafton, Westborough, Southborough and Framingham. It continues easterly into Boston. Route 140 travels north-south and provides a link between Shrewsbury and Grafton. Route 140 intersects Route 30 approximately 2 miles from the Route 30/Pine Street intersection.

Regional access to the site is generally good. The nearest Massachusetts Turnpike interchange is at Route 122, approximately 4.5 miles from the proposed station. Routes 140, 122, and 30 would provide additional network for the station. From the neighboring communities, primary access to the station is anticipated by means of the state highway system. Access from Oxford is via I-395 to Route 20. Route 20 intersects Route 140 north of the site in Shrewsbury. From Charlton, Route 20 to Route 140 affords the most direct route. Pine Street, and Route 140 to Route 30 will serve commuters from Shrewsbury; Route 30 will serve commuters from Westborough.

The critical location of the roadway network serving the station is the unsignalized intersection of Route 30/Pine Street. The existing roadway network serving the station appears to be operating under capacity.

Ridership Projection

The projected daily ridership at the Grafton station for the year 2010 is approximately 160 inbound person-trips for Rail Alternatives 1 and 2. The estimated ridership by community for each alternative is as follows:

	2010 Daily Inbound Person Trips	
	Rail Alt. 1 (Worcester)	Rail Alt. 2 (Worcester/Milford)
Grafton	30	30
Oxford	50	50
Charlton	20	20
Shrewsbury	20	20
Westborough	40	40
Total	160	160

Traffic Impacts and Recommendations

It is not anticipated that the traffic generated by the station will severely impact the adjacent roadway network. The proposed site is located in a rural setting. Roadways that would serve the proposed station appear to be operating under capacity and would have additional capacity to future 2010 traffic generated by the station.

Minor clearing is recommended on the north side of Route 30, along the westbound approach to the Route 30/Pine Street intersection, to improve sight distance for vehicles exiting Pine Street.

Worcester - Amtrak Station. The existing Amtrak Station, located on Shrewsbury Street, east of I-290, is the preferred site for the last station of the Worcester rail extension. The existing station access driveway is located approximately 100 feet from I-290 off-ramp. This station will primarily serve the communities of Worcester, Boylston, West Boylston, Sutton, Millbury, Auburn, and Spencer.

Roadway Network

The proposed station site is located in the downtown area of Worcester. Shrewsbury Street is a major arterial that joins Route 9 approximately 1.6 miles northeast of the site. To the west, Shrewsbury Street travels under I-290 and terminates at the Washington Square rotary. Shrewsbury Street is divided by a median island and is designated with two travel lanes in each direction. There are numerous signalized intersections along Shrewsbury Street; most of which have approaches consisting of two through lanes and an exclusive left-turn lane. Currently, Shrewsbury Street appears to be operating under capacity during the peak hours.

There are numerous collector roadways intersecting at Washington Square forming a rotary. From the rotary, Summer Street continues in a northerly direction to Route 9. Water Street travels southerly to its intersection with Franklin Street. Between Franklin Street and Route 122, Water Street is restricted to one way northbound. There are also two, one way roadways which connect Worcester Center Boulevard to the rotary.

Regional access to the site is via the numerous Interstate and State routes that serve Worcester. Interstate 190 provides access to the station from West Boylston. Interstate 190 terminates in Worcester at I-290. I-290 and Route 9 will provide access to the communities from the east such as Boylston and Shrewsbury. The communities of Sutton, Millbury and Auburn have easy access to downtown Worcester via I-395 which continues as I-290 north of the Massachusetts Turnpike. Route 9 links Spencer and other communities from the west to Worcester. Routes 122 and 146 will provide access from the communities to the southwest of Worcester. Routes 12, 70 and 122A are other State routes connecting Worcester to its abutting suburban communities. The Massachusetts Turnpike intersects I-290 approximately six miles south of the proposed station location.

Direct access to I-290 from the station is via the closely spaced interchanges at Central Street and Route 122. Access to I-290, east or west, is most direct via Mulberry Street located opposite the existing Amtrak driveway. The intersection of Shrewsbury Street/Mulberry Street/Amtrak driveway appear to require redesign to safely accommodate the additional traffic generated by the expansion of the Amtrak station.

The critical locations of the roadway network serving the station include the following:

- Washington Square rotary
- I-290/Central Street interchange
- I-290/Route 122 interchange
- Shrewsbury Street/South Hill Street
- Shrewsbury Street/Mulberry Street/station driveway

Ridership Projection

The projected daily ridership at the Worcester station for the year 2010 is approximately 880 inbound person-trips for Rail Alternatives 1 and 2. The estimated ridership by community for each alternative is as follows:

	2010 Daily Inbound Person Trips	
	Rail Alt. 1 (Worcester)	Rail Alt. 2 (Worcester/Milford)
Worcester	710	710
Boylston	20	20
West Boylston	10	10
Sutton	30	30
Millbury	20	20
Auburn	50	50
Spencer	40	40
Total	880	880

Traffic Impacts and Recommendations

The roadway network serving the Worcester station will be measurably impacted by the increase in traffic resulting from the proposed station. In particular, the rotary at Washington Square, the signalized intersection of Shrewsbury Street/South Hill Street (just east of the station) and the I-290/Central Street and I-290/Route 122 interchanges will require further evaluation.

As discussed previously, the intersection of Shrewsbury Street/Mulberry Street/the station driveway will require improvement. Upon further study it may be necessary to install traffic signals.

MILFORD EXTENSION

Holliston - Lowland Street. The station is located on Lowland Street approximately 650 feet east of Woodland Street, and one mile west of the Holliston/Sherborn town line. The existing track has divided the abutting land uses on Lowland Street. To the west of the station the land use is predominantly residential (thickly settled). To the east (on the northerly side) intense industrial use has occurred. This station will primarily serve the communities of Holliston, Millis and Sherborn.

Roadway Network

The location of this station is not as desirable as other preferred stations in terms of regional and local access. The station will only be served by one arterial, State numbered Route 16/126, and a number of collector/local distributor streets. The heavily travelled Route 16/126 will provide the primary link between the station and adjacent communities.

Lowland Street can be classified as a local street with variable cross sectional width. It intersects Woodland Street with a narrow approach width creating an uncontrolled T-intersection.

Lowland Street continues in a westerly direction intersecting Fiske Street approximately one-half mile east of the proposed station. Fiske Street is a collector street providing a link between the Town of Sherborn with the Town of Holliston business district area via Central Street. Central Street intersects Route 16/126 in Holliston center in a very dense environment. Route 16/126 is the major north-south arterial roadway in the Town of Holliston. Route 126 (known as Summer Street in Medway) joins Route 16 (known as East Main Street in Milford) approximately three miles south of the proposed site. Convergence of these two major routes on one arterial has resulted in peak hour congestion at many of the mid-segment intersecting streets. These two streets diverge in Holliston with Route 16 continuing to the Town of Sherborn and Route 126 maintaining its north-south alignment and continuing into the Town of Ashland.

From Millis, the most direct route to the station is via Middlesex Street which continues as Central Street in Holliston. Bullard Street intersects Central Street and continues northerly to Fiske Street. There are numerous collector roadways providing a link between Hopkinton and Holliston. Many of these converge onto Hollis Street which intersects Route 16 south of Lowland Street.

The critical locations of the roadway network serving the station are the unsignalized intersections of Route 16 and Route 126, Central Street and Route 16/126, Route 16 and Woodland Street, and the signalized intersections of Washington Street (Route 16) and Concord Street (Route 126), and Route 16/126 and Highland Street.

Ridership Projections

The projected daily ridership at the Lowland Street station for the year 2010 is approximately 630 and 640 inbound person-trips for Rail Alternatives 2 and 3, respectively. The estimated ridership by community for each alternative is as follows:

	2010 Daily Inbound Person Trips	
	Rail Alt. 2 (Worcester/Milford)	Rail Alt. 3 (Marlborough/Milford)
Holliston	220	250
Millis	310	320
Sherborn	70	70
Hopkinton	30	—
Total	630	640

Traffic Impacts and Recommendations

Traffic demands placed upon the existing transportation network (i.e., Route 16/126, Woodland Street, Central Street) are already significant and will become heavier in the near future, given the expected growth. The area's traffic problems are most evident during weekday peak commuting hours. Most noticeable problems envisioned for the study area roadways include inadequate capacity (i.e., Route 16/126) to process the peak commuting traffic demand and the lack of excess capacity and traffic control at major intersections (i.e., Route 16 and Route 126, Route 16/126 and Central Street, Route 16 and Woodland Street), serving the proposed station.

Milford - Webber's Lumber Yard. This station is located on Route 16, approximately one-half mile east of Route 109. The site has excellent regional access via I-495 affording regional highway connection at two diamond configured interchanges with State Route 16/85 approximately 1.5 miles north and State Route 109 approximately one-half mile south. This station will primarily serve the communities of Milford, Upton and Holliston.

Roadway Network

For station access Route 16 provides the primary link between local collector/distributor streets. In general, Route 16 is a two-lane facility (one lane per direction) serving both local and regional traffic. Route 16, in addition to providing access to adjacent commercial properties, is also utilized as a minor suburban arterial for north-south traffic between the Towns of Milford and Holliston.

The station traffic using I-495 from the south will enter the local roadway system at the Route 109 interchange and approach the site utilizing either Beaver Street to Route 16 or continuing on Route 109 to Route 16 signalized intersection.

Beaver Street is a two-lane roadway providing a direct link between Route 109 and Route 16. Beaver Street forms a four-way unsignalized intersection with Route 16 and Granite Park Road approximately one-quarter mile east of the site. Granite Park Road is a newly constructed facility (one mile) serving the industrial park and providing direct connection between Route 85 and Route 16. This roadway forms a four-way intersection with Route 85 and Dilla Street. Currently, this intersection is under construction with an anticipation of additional lanes on Route 85 and the provision of a fully actuated traffic signal control. This intersection is approximately one-quarter mile west of I-495/Route 85 interchange ramps.

Route 85 is an arterial roadway with one travel lane in each direction. Within the area, this facility has substantial continuity, connecting in a north-south direction between the Town of Milford and the communities of Hopkinton, Southborough and Marlborough. It continues south into downtown Milford as Main Street (Route 16).

Access from the communities of Milford and Holliston is anticipated via the collector roadways feeding Route 16. From Upton, Route 140/Route 16 provides the most direct route to the proposed station.

The critical locations of the roadway network serving the station are the unsignalized intersections of Beaver Street/Route 109, Beaver Street/Route 16/Granite Park Road, and the signalized intersection of Route 16 and Route 109.

Ridership Projection

The projected daily ridership at the Milford station for the year 2010 is approximately 220 inbound person-trips for Rail Alternatives 2 and 3. The estimated ridership by community for each alternative as follows:

	2010 Daily Inbound Person Trips	
	Rail Alt. 2 (Worcester/Milford)	Rail Alt. 3 (Marlborough/Milford)
Milford	150	150
Upton	30	30
Holliston	40	40
Total	220	220

Traffic Impacts and Recommendations

Based on our understanding of current traffic patterns and the projected daily ridership for this station, it appears that the roadway network system will need to be upgraded with a long range plan. As demonstrated, the station location has excellent regional access both in terms of regional interstate highway 495 and arterial State numbered Routes 109, 16, 85 and 140. However, additional capacity is needed at uncontrolled intersections in the immediate area.

MARLBOROUGH EXTENSION

Framingham - Salem End Road. The proposed Salem End Road station is located at the southeasterly corner (approximately 600 feet east) of the Salem End Road/ Maynard Road intersection in Framingham. Currently, this site serves as a parking facility for Framingham State College. It is anticipated that this station would primarily serve the communities of Framingham, Southborough and Sudbury under Rail Alternatives 3 and 4.

Roadway Network

Maynard Road is a local roadway which was divided by the construction of Route 9. In the vicinity of the site Maynard Road forms an unsignalized T-intersection with eastbound Route 9. This intersection is approximately 200 feet north of the Salem End Road/Maynard Road intersection. Maynard Road intersects Route 9 at a 90-degree angle. There are no acceleration or deceleration lanes on Route 9 at this intersection, hence turning movements to and from Route 9 are somewhat difficult.

Salem End Road is an arterial roadway with one travel lane in each direction. East of Maynard Road, Salem End Road terminates at an unsignalized skewed intersection with High Street, approximately 500 feet south of Route 9. Between Route 9 and Salem End Road, traffic on High Street is restricted to eastbound flow only (from Route 9); between Salem End Road and Main Street/ Edgell Road bidirectional travel is permitted.

The High Street/Main Street/Edgell Road intersection is currently signalized and appears to be operating at or over capacity during peak commuter hours. High Street terminates at this intersection; however, the alignment continues through the intersection as the Route 9 eastbound on-ramp. Edgell Road continues northerly through Framingham to the Framingham/Sudbury town line where it is designated as Nobscott Road in Sudbury. The Framingham/Sudbury town line is approximately four miles from the proposed station.

Salem End Road, west of Maynard Road, continues as Oregon Street in Ashland and Southborough. The Framingham/Ashland town line is approximately 2.5 miles from the proposed station. West of Maynard Road, Salem End Road forms two intersections with major collector roadways in the vicinity of the site. The intersection of Salem End Road/Winter Street is the closest signalized intersection to the site on Salem End Road. Winter Street continues southerly for approximately 1.5 miles to its intersection with Route 135. To the north, Winter Street intersects eastbound Route 9. Temple Street intersects Salem End Road approximately 2,000 feet west of Winter Street. North of Salem End Road, Temple Street intersects Route 9. Both the Winter Street and Temple Street intersections with Salem End Road currently appear to be at or over capacity.

Generally, Route 9 will provide direct access to the station from Framingham and Southborough. Commuters from Sudbury will utilize Edgell Road and High Street to access the station. It is not anticipated that users of the station will arrive via the Massachusetts Turnpike or I-495. However, for the occasional riders from the communities to the south and west, the Massachusetts Turnpike/Route 9 interchange is located approximately four miles from the proposed Salem End Road station.

The critical locations of the roadway network serving the station are the signalized intersections as listed below:

- High Street/Main Street/Edgell Road
- Salem End Road/Winter Street
- Salem End Road/Temple Street

Ridership Projection

The projected daily ridership at the Salem End Road station for the year 2010 is approximately 810 and 820 inbound person trips for Rail Alternatives 3 and 4, respectively. The estimated ridership by community for each alternative is as follows:

	2010 Daily Inbound Person Trips	
	Rail Alt. 3 (Marlborough/Milford)	Rail Alt. 4 (Marlborough)
Sudbury	410	420
Framingham	400	400
Total	810	820

Traffic Impacts and Recommendations

The traffic generated by the proposed Salem End Road station will measurably impact the above listed intersections. As these intersections appear to be operating at capacity, a further detailed traffic study is required.

Framingham - California Avenue. The preferred site for the West Framingham Station is located on California Avenue at the intersection of California Avenue/New York Avenue in Framingham Industrial Park. The site is approximately one-half mile from the Framingham/Southborough town line. This station will primarily serve the towns of Framingham, Southborough and Westborough.

Roadway Network

California Avenue is a local roadway that serves Framingham Industrial Park. It forms an signalized intersection with westbound Route 9 approximately 300 feet south of the proposed station. A triangular island channelizes entering and exiting vehicles. To the north, California Avenue terminates within the Park. New York Avenue is also a local roadway that serves the Park. It continues westerly from its unsignalized T-intersection with California Avenue into Southborough where it forms an unsignalized intersection with Route 30. Thus, local access to the proposed station is possible only from New York Avenue via Route 30.

Regional access to the site, however, is excellent. Approximately one-quarter mile east of the site is the Massachusetts Turnpike/Route 9 interchange. To the west, Route 9 intersects Route 30. This is a complex intersection consisting of a series of ramps. In addition to enabling traffic to access between Route 9 and Route 30, the ramps permit U-turn movements for vehicles on Route 9. The only control at this intersection is a STOP sign for vehicles making a U-turn from the eastbound to the westbound travelway. Willow Street connects Route 30 and westbound Route 9.

This intersection is currently under construction. Improvements involve the construction of a grade-separated flyover and a relocated Route 30 connector overpass. Figure 7-3 depicts both the existing and proposed roadway alignments for this intersection.
Vehicles approaching the site from Route 9 westbound would simply turn right onto California Avenue. From Route 9 eastbound, access to the site is via Route 30 eastbound to New York Avenue. Also, eastbound travelers could utilize the U-turn lane provided at the entrance to the Edgewater Hills apartment complex, located approximately one mile east of the intersection of Route 9/ California Avenue.

Overall, access to the site from the communities of Framingham, Southborough and Westborough is excellent via the Massachusetts Turnpike and numerous State highways that serve West Framingham.

The critical locations of the roadway network serving the California Avenue station are the Route 9/Route 30 intersection, currently under construction, the unsignalized intersection of Route 30/New York Avenue, and the signalized intersection of Route 9/California Avenue.

Ridership Projection

The projected daily ridership at the California Avenue station for the year 2010 is approximately 550 inbound person trips for both Rail Alternatives 3 and 4. The estimated ridership by community for both Alternatives 3 and 4 are as follows:

	2010 Daily Inbound Person Trips	
	Rail Alt. 3	Rail Alt. 4
Framingham	340	340
Westborough	210	210
Total	550	550

Traffic Impacts and Recommendations

Traffic generated by the California Avenue station does not appear to significantly impact the critical intersections discussed above. The improvements to the Route 9/Route 30 intersection should further facilitate access to the station.

Southborough - Southborough Center. This station is located on Park Street in Southborough Center approximately 500 feet south of the Route 30/Park Street intersection. This station is anticipated to serve only the community of Southborough.

Roadway Network

Park Street is a local roadway serving commercial and industrial abutters. It is a dead-end street which would be realigned as part of the station construction. The realignment will begin south of Route 30 and therefore will not effect the unsignalized T-intersection of Park Street with Route 30.

Route 30, designated as Main Street in Southborough center, is a major arterial serving east-west travel demands between the greater Boston metropolitan area and Grafton.

This two lane arterial intersects Route 85 approximately one-third mile west of Park Street at a signalized intersection. Route 85, a north-south roadway forms an interchange with Route 9 approximately one mile south of Route 30. As this station is expected to generally serve the community of Southborough, further discussion on regional access is not warranted. The following addresses the roadway network which converges in Southborough center.

Access to Southborough center from the residential areas of the community is via a network of collector and local roadways that feed the arterials roadways of Routes 30 and 85. Route 30 serves the easterly and westerly areas of Southborough and Route 85 serves the northerly and southerly areas. Collector roadways serving the northerly areas of Southborough that intersect Route 85 include Sears Road and Cross Street. Woodland, Richards and Mount Vickery Roads are collector roadways in south Southborough that contribute traffic to Route 85. Route 30 serves numerous collector roadways such as Sears, Deerfoot, and Parkerville Roads, and Newton and Central Streets.

Overall, the local roadway network in Southborough is adequate to serve a proposed station in Southborough center.

The critical locations of the roadway network serving the station are the signalized intersection of Route 30/Route 85 and the unsignalized intersection of Route 30/Park Street.

Ridership Projection

The projected daily ridership at the Southborough - Southborough Center station for the year 2010 is approximately 120 inbound person trips for Rail Alternatives 3 and 4. The station is anticipated to serve solely commuters from the Town of Southborough.

Traffic Impacts and Recommendations

It appears that a station in Southborough center serving approximately 120 commuters will not severely impact the roadway network immediate to the site. However, capacity constraints at the intersection of Route 30/Route 85 may exist by 2010. Geometric improvements and an updated traffic signal controller may provide adequate operation at this location.

The sight distance for motorist exiting Park Street onto Route 30 is constrained by the vertical alignment and parking along Route 30. Speed enforcement and elimination of parallel parking along the south side of Route 30 could improve the ability of motorist to safely exit Park Street.

Southborough - Northborough Road. This proposed station is located on Northborough Road approximately 1,000 feet west of the I-495 overpass. It is approximately one-third of a mile east of the Southborough/Marlborough town line. The station would require a realignment of Northborough Road from the I-495 overpass to the proposed site. This station will primarily serve the communities of Hudson, Marlborough, Hopkinton, Berlin, Northborough, and Southborough.

Roadway Network

The station site is located in a rural setting at the northwest corner of the town. Northborough Road functions as a collector roadway; west of the site it continues into Northborough where it forms an unsignalized intersection with Cedar Hill Road, Crane Meadow Road and D'Angelo Drive. Crane Meadow Road continues as Ames Street north of Forest Street and intersects Route 20. Access to Route 20 from the proposed station is approximately three miles along this route. East of the site, Northborough Road continues with a curving alignment and intersects Route 30. There is no traffic control; however, the intersection appears to operate as YIELD-sign controlled on Northborough Road. This intersection is approximately one and one-third mile from the proposed site.

Jericho Hill Road and Fisher Road are collector roadways which intersect Northborough Road east of I-495; they continue northerly into Marlborough center. Thus, local access from the communities of Southborough, Northborough and Marlborough is good.

From the northerly communities of Hudson and Berlin, the most direct route to the station is via I-495 to Route 20. As discussed previously, from Route 20 there are numerous intersecting roadways that travel south and intersect Northborough Road. From Hopkinton or Westborough, Interstate 495 to Route 9/Route 30 provides the most direct route to the proposed station. Overall, local and regional access to the station site is good.

It is our understanding that a new interchange at I-495 has been approved by the Federal Highway Administration. This interchange, as shown in Figure 7-4, will be located approximately two miles north of Route 9 interchange and one mile south of Route 20 interchange.

The proposed design is a trumpet/half diamond interchange, with a four lane connector road of approximately one-third of a mile in length between the interchange and Crane Meadow Road. This interchange will significantly improve regional access to the proposed station.

The critical locations of the roadway network serving the station include the unsignalized intersections of Route 30/Northborough Road, Northborough Road/Crane Meadow Road/D'Angelo Drive/Cedar Hill Road, and Forest Street/Crane Meadow Road/Ames Street, and the signalized intersection of Route 20/Ames Street.

Ridership Projection

The projected daily ridership at the Northborough Road station for the year 2010 is 640 and 790 inbound person-trips for Rail Alternatives 3 and 4, respectively. The estimated ridership by community for each alternative is as follows:

	2010 Daily Inbound Person Trips	
	Rail Alt. 3 (Marlborough/Milford)	Rail Alt. 4 (Marlborough)
Hudson	50	90
Marlborough	280	330
Hopkinton	140	180
Berlin	20	30
Northborough	80	90
Southborough	70	70
Total	640	790

Traffic Impacts and Recommendations

Based on a review of the Maggiori Industrial Park Traffic Impact and Access Study prepared by HMM Associates in June 1988, it appears that all of the critical intersections that will serve the proposed Northborough Road station will operate at or over capacity in the near future. The study presents a series of improvement plans for most of these intersections.

It is recommended that this station location be further evaluated. The study should detail the additional improvements for accommodations of the proposed station-generated traffic.

Conclusions

This section of the report has presented an overview of the preferred station locations in terms of traffic roadway network and access requirements. The 2010 ridership projections for each station location were also obtained from CTPS and assignments were slightly modified to reflect location of the station in terms of adjacent communities and the existing roadway network. Constrained intersections and roadways have been identified, qualitatively evaluated and further recommendations were made.

An evaluation of the projected ridership under each rail alternative indicates that Alternative 2 would benefit the greatest number of commuters. A total of 4,250 daily inbound commuters are estimated to utilize the Worcester and Milford rail extensions as proposed under Rail Alternative 2.

Rail Alternative 3 would also benefit a more significant number of commuters than Alternatives 1 and 4. This alternative which recommends rail extensions to Marborough and Milford would serve approximately 4,230 daily inbound person-trips, approximately equal to projected ridership with Rail Alternative 2.

Of the preferred stations, the Worcester station will serve the largest number of commuters (approximately 880 daily person-trips) as part of either Alternatives 1 or 2. The Salem End Road station will also serve a significant number of commuters. This station would be constructed as part of Rail Alternatives 3 and 4 and would serve approximately 820 daily person-trips for both alternatives.

Improvements are anticipated at many roadway network locations serving the stations. Improvements to intersections generally involve signalization and/or geometric improvements. These types of improvements are relatively inexpensive and fairly easily accomplished. For the station sites proposed at Salem End Road in Framingham and Lowland Street in Holliston, more extensive mitigation measures are anticipated.

Route 9 would predominantly serve the Salem End Road station. The segment of Route 9 corridor in the vicinity of the proposed station is currently approaching its physical capacity during peak commuting hours. By design year 2010 this corridor is expected to operate over capacity. As the entire corridor will be affected, simple use of low cost management actions will not suffice. Simply, additional lanes will be required in many segments of the corridor.

A similar situation exists on Route 16/126 corridor in Holliston serving proposed Lowland station. Widening segments of Route 16/126 corridor from two lanes to four lanes would be necessary to accommodate projected 2010 traffic.

In summary, the variety of issues identified among the travel needs of the station locations can be specifically related to one common factor. In each instance the problem causing deficiencies seems to occur in one form or another on State numbered routes. As the major carriers of traffic, it seems reasonable to expect that efforts to improve traffic conditions at nearby stations should concentrate on improving operating conditions along these major thoroughfares. The selection and testing of alternative solutions to the deficiencies should be addressed in a subsequential detailed study report.

TABLE 7-1

NATURAL RESOURCES SUMMARY OF STATION SITES FOR WORCESTER, MILFORD AND MARLBOROUGH EXTENSIONS

Station Location	Water Resources			Rare/Endangered Wetlands Wildlife	Water Quality Standard[1]
	Wetlands	Floodplain	Aquifer		
WORCESTER EXTENSION					
Ashland					
1. Ashland Center	Not present on-site. Possibly within 100 feet of site.	Not located within mapped floodplain.	Aquifer protection district bylaws and maps are currently under revision.	None identified.	Sudbury River "B"[2]
2. Cherry Street	Present on-site and within 100 feet of site.	Not located within mapped floodplain.	Same	None identified.	Sudbury River "B"
3. Howe Street (Preferred)	Present within 100 feet of site.	100-year floodplain mapped on-site.	Same	None identified.	Sudbury River "B"
Southborough					
4. Route 85	Possibly on-site, definitely within 100 feet.	100-year floodplain mapped on-site.	Southborough does not currently have an aquifer protection district bylaw.	Site is immediately adjacent to an area identified by the Natural Heritage Program as an estimated habitat for rare wetlands wildlife.	Sudbury River "B"
Westborough					
5. Fruit Street (Preferred)	Present within 100 feet of site.	100-year floodplain mapped on-site.	Not located within designated Aquifer and Watershed Protection District.	None identified.	Sudbury River "B"

TABLE 7-1 (Continued)

NATURAL RESOURCES SUMMARY OF STATION SITES FOR WORCESTER, MILFORD AND MARLBOROUGH EXTENSIONS

Station Location	Water Resources			Rare/Endangered Wetlands Wildlife	Water Quality Standard
	Wetlands	Floodplain	Aquifer		
Grafton					
6. Pine Street (Preferred)	Present within 100 feet of site.	Not located within mapped floodplain.	Not located within designated Aquifer Protection District.	None identified.	Blackstone River "B"[3]
7. Parmenter Crossing	Present on-site and within 100 feet of site.	100-year floodplain mapped on-site.	Site located within Aquifer Protection District.	None identified.	Blackstone River "B"
8. Milepost 38.75	Present on expansion area and within 100 feet of primary area.	Not located within mapped floodplain.	Site located within Aquifer Protection District.	None identified.	Blackstone River "B"
Worcester					
9. Amtrak Station (Preferred)	Not present on-site nor within 100 feet of site.	Not located within mapped floodplain.	The City of Worcester does not have an aquifer protection district.	None identified.	Middle River "B"[3]
10. Salem Municipal Lot	Not present on-site nor within 100 feet of site.	Not located within mapped floodplain.	Same	None identified.	Middle River "B"
11. Wyman Gordan	Not present on-site nor within 100 feet of site.	Not located within mapped floodplain.	Same	None identified.	Middle River "B"
12. Trailways Bus	Not present on-site nor within 100 feet of site.	Not located within mapped floodplain.	Same	None identified.	Middle River "B"

TABLE 7-1 (Continued)

NATURAL RESOURCES SUMMARY OF STATION SITES FOR WORCESTER, MILFORD AND MARLBOROUGH EXTENSIONS

Station Location	Water Resources			Rare/Endangered Wetlands Wildlife	Water Quality Standard
	Wetlands	Floodplain	Aquifer		
13. Millbury Street North	Not present on-site, but present within 100 feet of site.	100-year floodplain possibly located within site boundaries.	Same	None identified.	Blackstone River "B"[3]
14. Millbury Street South	Present within 100 feet of site.	100-year floodplain possibly located within site boundaries.	Same	None identified.	Blackstone River "B"
Millbury					
15. Route 146 / Mass Pike	Present within 100 feet of site.	Not located within mapped floodplain.	Not located within Aquifer and Watershed Protection Overlay District.	None identified.	Blackstone Rivier "B"
MILFORD EXTENSION					
Holliston					
16. Parker Snacks	Present on-site and within 100 feet of site.	Not located within mapped floodplain.	Located within Aquifer Protection District.	Site located within an area identified by the Natural Heritage Program as an estimated habitat for rare wetlands wildlife.	Charles River "B"[2,3]
17. Lowland Street (Preferred)	Present within 100 feet of site.	Not located within mapped floodplain.	Located within Aquifer Protection District.	None identified.	Charles River "B"

TABLE 7-1 (Continued)

NATURAL RESOURCES SUMMARY OF STATION SITES FOR WORCESTER, MILFORD AND MARLBOROUGH EXTENSIONS

Station Location	Water Resources			Rare/Endangered Wetlands Wildlife	Water Quality Standard
	Wetlands	Floodplain	Aquifer		
18. Holliston Center	Not present on-site nor within 100 feet of the site	Not located within mapped floodplain.	Located within Aquifer Protection District.	None identified.	Charles River "B"
19. Hopping Brook	Present on-site and within 100 feet of site.	Located within mapped floodplain.	Located within Aquifer Protection District.	None identified.	Charles River "B"
Milford					
20. Webber's Lumber Yard (Preferred)	Present on-site and within 100 feet of site	Not located within mapped floodplain.	Town of Milford does not possess aquifer protection bylaws.	None identified.	Charles River "B"
21. Sears	Present on-site and within 100 feet of site.	Not located within mapped floodplain.	Same	None identified.	Charles River "B"
MARLBOROUGH EXTENSION					
Framingham					
22. Salem End Road (Preferred)	Not present on-site, possibly present within 100 feet of site.	Not located within mapped floodplain.	The City of Framingham does not have an aquifer protection bylaw.	None identified.	Assabet River "A"[1]
23. California Avenue (Preferred)	Present on-site and within 100 feet of site.	Not located within mapped floodplain.	Same	None identified.	Assabet River "A"

TABLE 7-1 (Continued)

NATURAL RESOURCES SUMMARY OF STATION SITES FOR WORCESTER, MILFORD AND MARLBOROUGH EXTENSIONS

Station Location	Water Resources			Rare/Endangered Wetlands Wildlife	Water Quality Standard
	Wetlands	Floodplain	Aquifer		
Southborough					
24. Southborough Center (Preferred)	Present on-site and within 100 feet of site.	Not located within mapped floodplain.	The Town of Southborough does not currently have an aquifer protection bylaw.	None identified.	Assabet River "A"
25. Northboro Road (Preferred)	Present on-site and within 100 feet of site.	Not located within mapped floodplain.	Same	None identified.	Assabet River "A"

[1] Class A Waters are designated for use as a source of public drinking water.
Class B Waters are designated for the uses and protection and propagation of fish, other aquatic life and wildlife, and primary and secondary contact recreation.

[2] Cold Water Fishery (seasonal)/Recreation (Primary and Secondary Contact).

[3] Warm Water Fishery/Recreation (Primary and Secondary Contact).

(Preferred) - Station site designated as preferred.

TABLE 7-2

REGULATORY MATRIX APPLICABLE TO STATION SITES

Station Site	Wetlands			Aquifer	Floodplain	Rare Wetlands Wildlife Habitat	Water Quality Standard
	Federal - Section 404	State - M.G.L. Ch. 131, s.40 & 310 CMR 10.00	Local - Zoning/Non Zoning Bylaw	Local - Zoning Bylaw	Local - Zoning Bylaw	Local - M.G.L. Ch. 131, s.40 & 310 CMR 10.00	State - M.G.L. Ch. 121, s.27 & 314 CMR 4.00
WORCESTER EXTENSION							
Ashland							
1. Ashland Center	N/A	X (Buffer Zone)	N/A	N/A	N/A	N/A	X
2. Cherry Street	X	X (Buffer Zone)	Not within locally delineated wetland resource area.	N/A	N/A	N/A	X
3. Howe Street (Preferred)	X	X	Not within locally delineated wetland resource area.	N/A	X	N/A	X
Southborough							
4. Route 85	N/A	X (Buffer Zone)	X (Zoning Bylaw)	N/A	X	N/A	X
Westborough							
5. Fruit Street (Preferred)	X	X	N/A	N/A	X	N/A	X

TABLE 7-2 (Continued)

REGULATORY MATRIX APPLICABLE TO STATION SITES

	Wetlands			Aquifer	Floodplain	Rare Wetlands Wildlife Habitat	Water Quality Standard
Station Site	Federal - Section 404	State - M.G.L. Ch. 131, s.40 & 310 CMR 10.00	Local - Zoning/Non Zoning Bylaw	Local - Zoning Bylaw	Local - Zoning Bylaw	Local - M.G.L. Ch. 131, s.40 & 310 CMR 10.00	State - M.G.L. Ch. 121, s.27 & 314 CMR 4.00
Grafton							
6. Pine Street	N/A	X	X	N/A	N/A	N/A	X
7. Parmenter Crossing	X	X	X	X	X	N/A	X
8. Milepost 38.75	X	X	X	X	N/A	N/A	X
Worcester							
9. Amtrak Station (Preferred)	N/A	N/A	N/A	N/A	N/A	N/A	X
10. Salem Municipal Lot	N/A	N/A	N/A	N/A	N/A	N/A	X
11. Wyman Gordon	N/A	N/A	N/A	N/A	N/A	N/A	X
12. Trailways Bus	N/A	N/A	N/A	N/A	N/A	N/A	X
13. Millbury Street North	N/A	X	N/A	N/A	X	N/A	X
14. Millbury Street South	N/A	X (Buffer Zone)	N/A	N/A	X	N/A	X
Millbury							
15. Route 146 / Mass Pike	X	X (Buffer Zone)	X	N/A	N/A	N/A	X

TABLE 7-2 (Continued)

REGULATORY MATRIX APPLICABLE TO STATION SITES

	Wetlands			Aquifer	Floodplain	Rare Wetlands Wildlife Habitat	Water Quality Standard
Station Site	Federal - Section 404	State - M.G.L. Ch. 131, s.40 & 310 CMR 10.00	Local - Zoning/Non Zoning Bylaw	Local - Zoning Bylaw	Local - Zoning Bylaw	Local - M.G.L. Ch. 131, s.40 & 310 CMR 10.00	State - M.G.L. Ch. 121, s.27 & 314 CMR 4.00
MILFORD EXTENSION							
Holliston							
16. Parker Snacks	X	X	X	X	N/A	X	X
17. Lowland Street (Preferred)	N/A	X (Buffer Zone)	N/A	X	N/A	N/A	X
18. Holliston Center	N/A	N/A	N/A	X	N/A	N/A	X
19. Hopping Brook	X	X	X	X	X	N/A	X
Milford							
20. Webber's Lumber Yard (Preferred)	X	X	N/A	N/A	N/A	N/A	X
21. Sears	X	X	N/A	N/A	N/A	N/A	X
MARLBOROUGH EXTENSION							
Framingham							
22. Salem End Road (Preferred)	N/A	X (Buffer Zone)	N/A	N/A	N/A	N/A	X

TABLE 7-2 (Continued)

REGULATORY MATRIX APPLICABLE TO STATION SITES

	Wetlands			Aquifer	Floodplain	Rare Wetlands Wildlife Habitat	Water Quality Standard
Station Site	Federal - Section 404	State - M.G.L. Ch. 131, s.40 & 310 CMR 10.00	Local - Zoning/Non Zoning Bylaw	Local - Zoning Bylaw	Local - Zoning Bylaw	Local - M.G.L. Ch. 131, s.40 & 310 CMR 10.00	State - M.G.L. Ch. 121, s.27 & 314 CMR 4.00
23. California Avenue (Preferred)	X	X	N/A	N/A	N/A	N/A	X
Southborough							
24. Southborough Center (Preferred)	X	X	N/A	N/A	N/A	N/A	X
25. Northboro Road (Preferred)	X	X	N/A	N/A	N/A	N/A	X

(Preferred) - Station site designated as preferred
X - Applicable
N/A - Not Applicable - either no jurisdiction or no applicable law/regulation

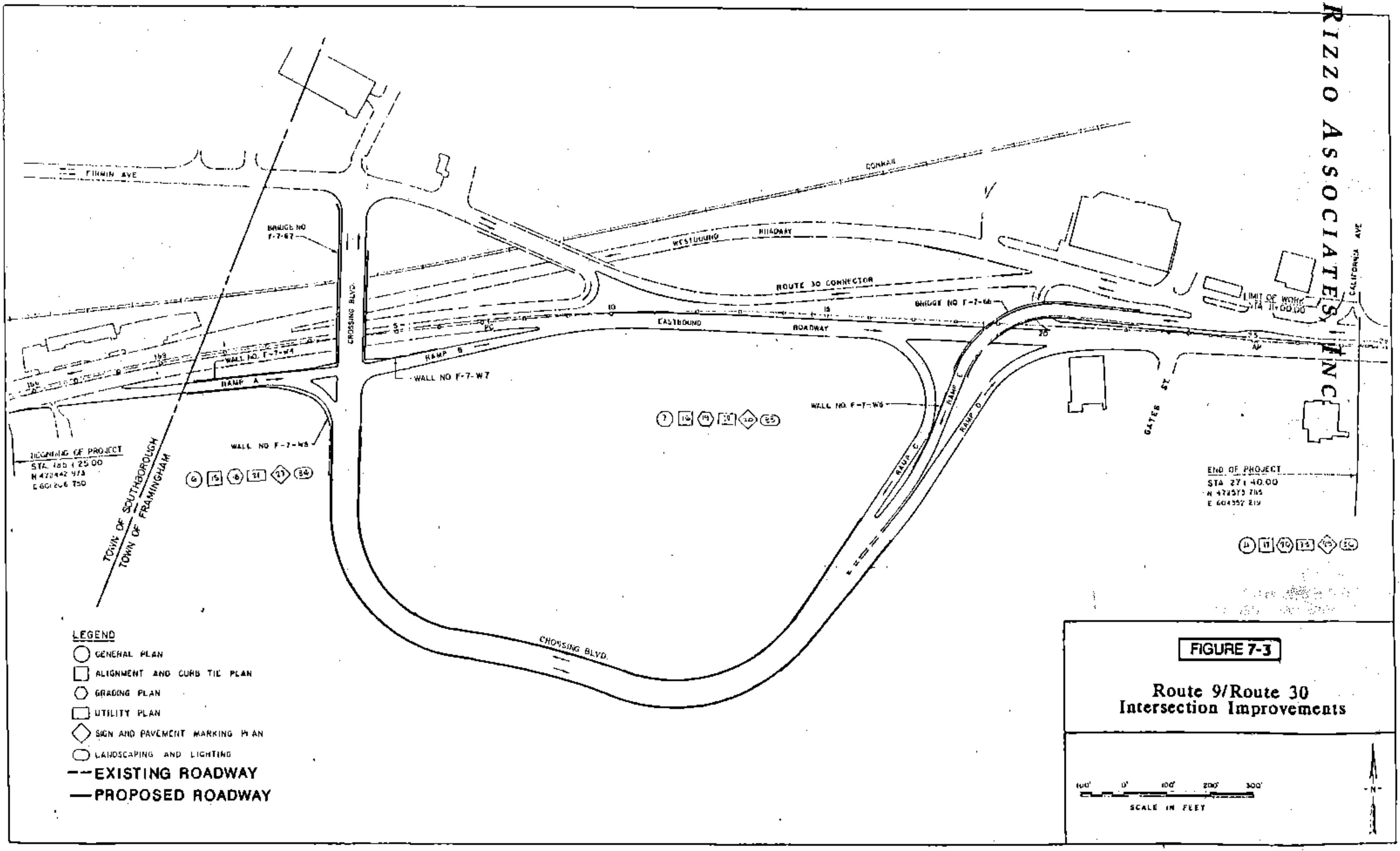
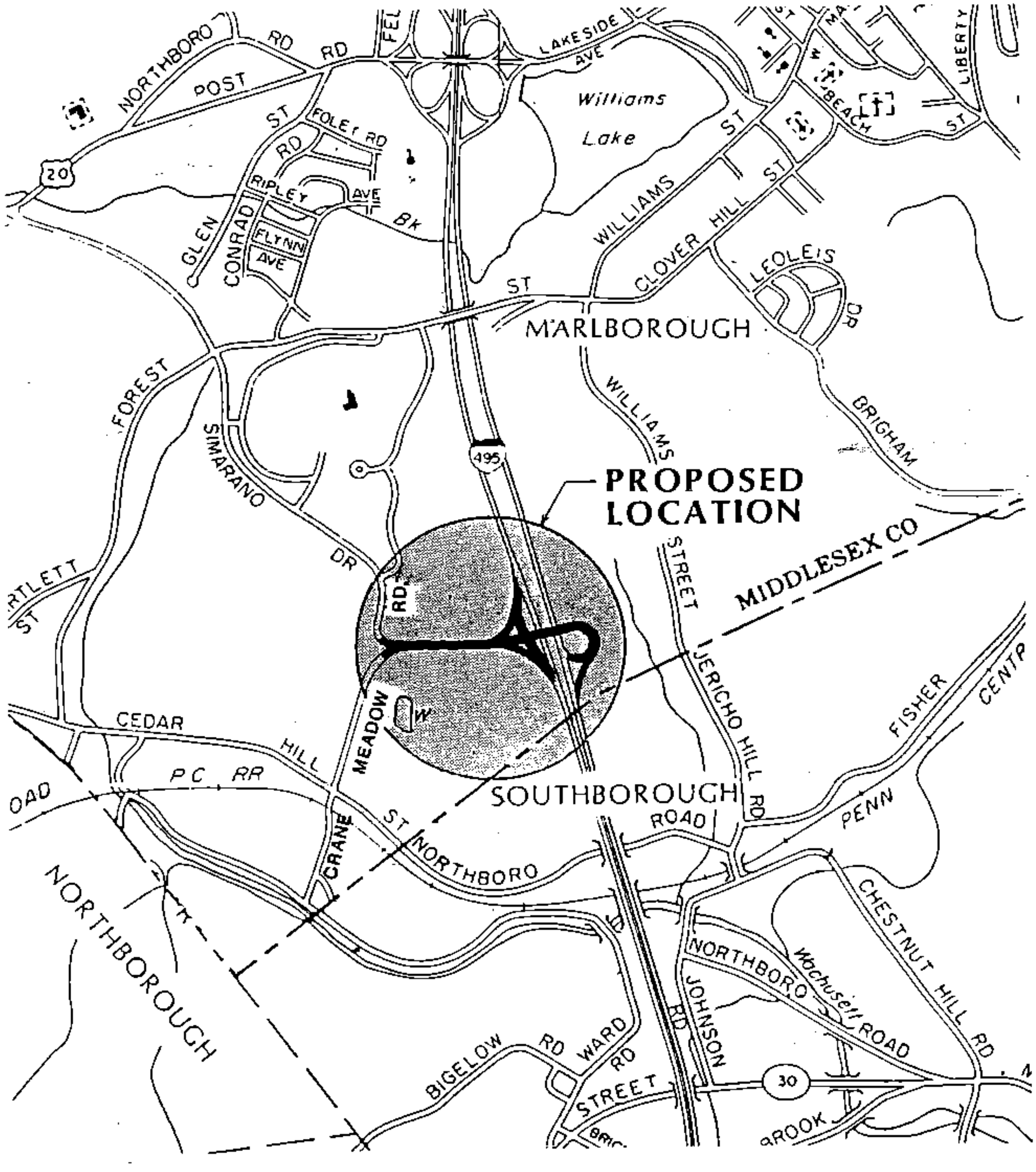


FIGURE 7-3

Route 9/Route 30 Intersection Improvements



Commuter Rail Extension
Feasibility Study

0 2000
Scale In Feet

N

FIGURE 7-4

Proposed I-495 Interchange
and Connector Road

CHAPTER 8

ECONOMIC EVALUATION

8.1 SUMMARY OF CAPITAL INVESTMENT

Table 8-1 summarizes the capital investment required for the improvements and rolling stock discussed in Chapters 3, 4 and 6. The track, signal, communications and grade crossing protection costs assume that existing infrastructure is either replaced or rehabilitated, as appropriate, to current MBTA commuter rail design standards. Bridge and culvert rehabilitation is generally limited to pointing and/or sandblasting and painting except where specifically noted.

8.2 OPERATING AND MAINTENANCE COSTS

Overview of Operating and Maintenance Cost Approach

This section addresses the operating and maintenance costs associated with extending rail service to the Worcester, Marlborough and Milford areas. Since each alternative consists of a series of bus and rail services, the costs of the bus and rail components as well as total operating and maintenance cost of the services to serving the study area were estimated. Because service is already in place, as far west as Framingham, a marginal costing approach was adopted for evaluation purposes. That is, the additional costs associated with extending rail service beyond Framingham were estimated. This approach to operations and maintenance costing is consistent with the evaluation of capital cost and ridership impacts. At the same time, the operations and maintenance costs have been estimated using a resource buildup model as recommended by UMTA; this type of approach incorporates an allocation of system-wide costs where additional costs can be anticipated. This section summarizes the results obtained for each of the alternatives. Appendix E contains a description of the methodology utilized to compute rail operating and maintenance costs.

Estimation of Operating and Maintenance Costs

The following discusses the preparation of the service specifications for each alternative necessary for the estimation of rail and bus operating and maintenance costs.

Rail Service Specifications

The Commuter Rail O&M Cost Model requires the specification of a number of service related variables to estimate costs. Among the service variables are: revenue train hours, revenue train miles, and number of route miles. The revenue train hours and revenue train miles were specified based on the operating plan identified in Chapter 2 which was adjusted to reflect the patronage estimates identified in Chapter 5.

The revenue train hours are the principal inputs required to calculate the costs of operating labor. Basic crew service costs are calculated from all day revenue train hours, while costs for supplementary crews used only during the peak period are based on peak revenue train hours.

For the costing of various maintenance and transportation elements, the model requires the number of locomotives and cars and locomotive- and car-miles, which depend upon the number and length of trains scheduled to meet demand.

The model also requires specification of the number and nature of physical facilities such as track, roadbed, bridges, and stations. Specific model inputs include track miles, and number of bridges, stations, grade crossings, and number of non station buildings.

The critical specifications of each alternative which served as input to the rail O&M cost model are shown in the upper portion of Table 8-2.

Bus Service Specifications

The private carrier express bus operating and maintenance costs were also estimated using a cost model developed for the Old Colony study. The model was calibrated on data assembled from a broad based group of private carriers, ranging from small family businesses to large unionized bus operations. Thus the productivities (resource input units per service output unit) and unit costs reflected in the model represent the average conditions within this range.

Much simpler in structure than the rail cost model, the bus model relies on relatively few service unit input variables. Labor costs of operation are based on revenue bus miles and number of bus round trips. Servicing of vehicles is based on revenue bus miles as well, while facility maintenance costs are based on the number of park and ride facilities.

Note that the current express bus services are all operated by private carriers. Thus, the cost estimation was based on continued private carrier operation of any continued or enhanced express bus operation. It is recognized that the private carriers have somewhat different cost structures. For the feasibility study, it was deemed adequate to apply the private carrier express bus cost model based on the average of all carriers, rather than attempt to estimate a model for each particular carrier.

The critical specifications of each alternative which served as input to the bus O&M cost model are shown in the upper portion of Table 8-3.

Operating and Maintenance Cost Estimates

Based on the specifications identified above, reflecting the service levels described for each alternative in Chapter 2, operating and maintenance costs were estimated using the O&M cost models. Presented below are the results for rail and bus components of the alternatives, followed by a summary of total operating and maintenance cost associated with service to the study area.

Rail Costs

Table 8-2 presents the annual operating and maintenance cost estimate for each rail alternative in 1989 dollars. First, the costs of the new services are presented, followed by the costs of the Framingham service that would be supplanted. The resulting net cost of operating service beyond Framingham is the final result.

Alternative 4 serving Marlborough is the least costly in terms of operating and maintenance net cost at approximately $4.3 million annually. This net cost excludes all costs of continuing Framingham service, but takes into account the savings resulting from reducing peak Framingham service and eliminating off-peak Framingham service (which would be provided by the Marlborough trains).

Alternative 1 serving the Worcester extension with express trains also requires the continuation of a separate Framingham peak period service. That alternative costs $5.1 million over and above the operation of Framingham service. Alternative 3 is the next least costly, at $6.3 million. It includes a short extension to Milford added on to the service of Alternative 4. The most costly alternative is Alternative 2, costing over $7 million.

Alternatives 2 and 3 have a higher "new service" cost than Alternatives 1 and 4, since they include separate local and express services that originate west of Framingham.

Unit costs measured in cost per passenger also indicate that Alternative 4 has the lowest operating and maintenance cost, at $3.50 per passenger. Alternative 3 has a higher ost per passenger, at $4.46. The Alternative 3 cost is again reflective of the expense associated with extending service associated with Alternative 4 to Milford. Although Alternatives 1 and 2 have higher costs per passenger, at $4.33 and $4.98 respectively, those two alternatives do not serve the Framingham Center/West Framingham market that is served by Alternatives 3 and 4. The lower cost per passenger of Alternatives 3 and 4 is directly related to the large number of passengers forecast for the Salem End Road and California Avenue stations on the Marlborough branch.

When productivity in passengers per revenue car mile is examined, Alternatives 3 and 4 are the most productive, at 2.83 and 2.47 passengers per revenue car mile respectively, again due to the large number of passengers at the new Framingham stations. Alternative 1 carries 1.78 passengers per car mile due to the greater number of car miles associated with the longer distance to Worcester. Similarly, Alternative 2 has 1.96 passengers per revenue car mile, due to the addition of passengers from Milford to Alternative 1 service. The low productivities for Alternatives 1 and 2 are relative to the smaller number of passengers generated on the Worcester branch and the large number of train miles.

Alternative 4 has the highest net cost per revenue train mile of the four Alternatives, at $35.82. The other alternatives range from $22.86 to $32.60 per revenue train mile. The high unit cost for Alternative 4 is attributable to the lower number of train miles but longer consists required to operate that service, when compared to the other alternatives.

Bus Costs

Bus services are included in a number of the alternatives. The baseline alternative for the analysis is the Bus Alternative, which assumes no extension of rail service beyond its current Framingham terminus -- that is, no commuter rail service to Worcester or Marlborough, and no service to Milford via Framingham; Milford is assumed to be served by an extension of the Franklin branch. Instead, the Bus Alternative includes improvements to existing express bus services serving these communities to and from downtown Boston.

In addition, each of the rail alternatives included continued operation of express bus services to portions of the study area not directly served by rail. For example, in the rail alternatives that provide rail service to Marlborough, the express bus from Worcester to Boston continues to operate. Although it is possible that private carrier express bus service from Worcester might continue in Alternatives 1 and 2, the ridership forecasting model which performs an all or nothing assignment, forecast no riders on these services. As a result, express bus service from Worcester to Boston is not included in those alternatives. Similarly, the semi-express service was not assigned any trips in any of the rail alternatives. As a result, the semi-express service is only included in total operating and maintenance costs for the Bus Alternative. Alternatives 1 and 2 have no significant bus operating costs, since the ridership forecasting model assigned no riders to the Marlborough bus service.

Note that only express bus services were costed. The local bus services which might be slightly modified to improve access to rail stations were not considered as integral elements of the alternatives and therefore were not addressed in the operations and maintenance cost analysis.

Table 8-3 summarizes the costs associated with the express bus services. Due to the limited bus services that are provided on routes other than the Worcester/Boston express, the difference between the costs of the Bus Alternative and the cost of bus services that would be included in rail Alternatives 3 and 4 is less than $0.5 million.

On a cost per passenger basis, the Bus Alternative has a unit cost of $1.96. The bus service included in Alternatives 3 and 4, by comparison, costs $2.23 per passenger. This difference can be attributed to the larger number of passengers attracted to the enhanced bus service in the Bus Alternative. On a cost per passenger basis, the Bus Alternative is only slightly more expensive than the rail service in Alternative 4, and is slightly less expensive than the rail service in Alternative 3. However for serving Worcester, the Bus Alternative is less costly than either of the rail alternatives.

Total Operating and Maintenance Costs

Table 8-4 combines the costs of bus and rail components into a single total operating and maintenance cost for serving the study area communities. This enables us to identify the overall expenditure for operating each alternative. Of course, it should be recognized that these total costs do not represent the cost to the MBTA. The MBTA would operate the commuter rail service but has only a limited role in subsidizing express bus service.

The net result of the operating and maintenance cost analysis is that the lowest operating cost alternative on an annual basis is the Bus Alternative with a cost of $1.5 million. Alternative 1 is the next least costly alternative, with a cost of $5.1 million, all due to rail service, as there are no bus services included in that alternative. The remaining alternatives cost between $5.4 million to just over $7.3 million. Bus service is not included in the cost of Alternative 2, but is included in the cost of Alternatives 3 and 4.

On a total operating cost per passenger basis, the Bus Alternative is the least expensive alternative, at $1.96 per passenger. Of the rail alternatives, the lowest cost per passenger is achieved by Alternative 4. Its cost per passenger is reflective of both bus and rail service, and is $3.15 per passenger. The other alternatives range between $3.90 and $4.98 per passenger, with Alternative 3 being the most costly, due to its higher overall resource cost and its inability to attract a great deal of ridership from the Milford area.

To obtain a true comparison of the costs of alternatives, amortized capital costs must be added to, and passenger revenues must be subtracted from, the annual operating and maintenance cost. Section 8.3 describes the development of revenue estimates for extension stations, and Section 8.4 develops the annualized capital costs incurred so that the overall cost effectiveness of each alternative can be assessed.

8.3 REVENUES

In order to calculate the estimated revenue for each rail alternative, several steps were necessary. First, existing MBTA fare zones were extended outward from Framingham for each alternative. The fare zone for each extension station was determined by comparing the distance of the extension station from Boston with stations on the existing commuter rail system that are a similar distance from Boston. The zone designation for the existing stations was then assigned to the extension station.

Second, the most recent MBTA commuter rail fare audit was examined, in order to determine average fare per passenger. However, the latest available fare audit was conducted in March, 1989. At that time, cash fares had increased, but multi-ride tickets and monthly passes had not yet been increased. A new average fare was calculated based on the same distribution of passengers using passes and multi-ride tickets, but at the increased rates effective later in 1989.

Based on new revenue calculations for existing Zone 4 and Zone 5 stations on the Framingham branch, the average fare is about 90 percent of the cash fare. For example, for Zone 4, the 1989 cash fare is $2.50, while the average fare is approximately $2.28. For Zone 5 passengers at Framingham Downtown, the 1989 cash fare is $2.75, and the average fare is $2.40. The average fare was then calculated for each extension station, based on the ratio of average fares to cash fares found for Zones 4 and 5. The average fare was then applied to the estimated number of inbound passenger trips at each station.

Note that actual average fares may vary by station, due to possible variations in monthly pass usage. Riders from stations located farther from Boston may be less likely to travel five or more days per week. As a result, these riders may be less likely to purchase a monthly pass. Should a lesser number of passes be used, the average fare would increase to reflect a greater number of cash fares or multi-ride tickets, which are not discounted as much as monthly passes. The extension stations, their designated fare zones, 1989 cash fares, and average fares are shown in Table 8-5 and the resulting revenue calculation by alternative is presented in Table 8-6.

In summary, the revenue estimates are:

•Alternative 1	$3.82 million
•Alternative 2	$4.94 million
•Alternative 3	$2.62 million
•Alternative 4	$1.70 million

8.4 COMPARISON OF ALTERNATIVE COSTS

Total Annual Cost

UMTA guidelines for major capital investments require that all evaluation measures for costs and revenues be expressed in annual terms. Capital cost estimates are generally prepared as a total expenditure of base year dollars, while operating and maintenance costs are expressed in annual dollars. In order to combine operating and capital costs, an equivalent annual payment must be calculated for the capital expenditures.

Annualized capital costs are estimated as the total capital cost of an expenditure multiplied by its annualization factor. Annualization factors reflect the discount rate and the lifespan of a capital investment as established by UMTA. Land acquisition and roadbed were considered to have a life cycle of 100 years, while most other capital facilities have shorter life cycles. Track, sidings, bridges, signals, stations and layover facilities were estimated to have a life cycle of 30 years. Grade crossings and fencing were annualized over 20 years. Rail equipment, such as cars and locomotives, was estimated to last 25 years before being replaced, while bus equipment was estimated to have a lifespan of 12 years. The resulting annualized capital cost for each alternative reflects the cost allocated to one year in the life cycle for each capital expenditure.

The total annual cost is the sum of annualized capital costs and annual operating costs. The total annual cost for the rail portion of each alternative ranges from $13.4 million for Alternatives 1 and 4 upwards to $17.9 and $18.6 million for Alternatives 3 and 2 respectively.

Bus service costs were annualized in a similar manner. Due to the relatively small amount of bus service in the rail alternatives, the added annualized cost of bus service added $1.3 million to the rail annualized costs for those alternatives that combined both types of service. In the Bus Alternative, the annualized costs of providing that service are $2.2 million.

A total annual cost that combines the rail and bus annualized costs was developed for each alternative, to allow the comparison of the Bus Alternative with the rail alternatives. The Bus Alternative has an annual cost of $2.2 million due to the modest capital investments associated with that alternative. The rail alternatives are considerably more costly, due to the investment in capital facilities.

Alternative 1 is the least costly rail alternative, at $13.4 million per year, while Alternative 3 is the most costly at $19.2 million. The additional cost of building and maintaining the branched service in that alternative contribute to the high net annual cost. Alternatives 4 and 2 have annualized costs of $14.7 and $18.6 million, respectively.

Table 8-7 contains the annual operating and maintenance costs, annualized vehicle costs, annualized construction costs, and total annualized costs for each alternative.

Net annual cost is the total annualized cost less annual revenues. For each alternative, the net annual cost of the rail service is:

Alternative 1	$14.9 million
Alternative 2	$16.9 million
Alternative 3	$16.1 million
Alternative 4	$15.9 million

- Recovery Ratios

Another measure of cost effectiveness that can be used to evaluate the proposed rail extensions is the recovery ratio. In this measure, annual revenues are compared to operating and maintenance costs. The MBTA has indicated that fares should recover at least 33 percent of operating costs. The ratio of rail revenues to rail operating costs ranges from 0.75 for Alternative 1 to 0.40 for Alternative 4. Alternative 2 is the next most effective in this respect, with a recovery ratio of 0.69. The similarity between the operating cost ratios of Alternatives 1 and 2 is due to the dominant effect of the Worcester express service's fare revenue contribution over the modest addition of service to Milford. Alternative 3 has a recovery ratio of 0.41, owing in large measure to the shorter trips and hence lower average fare on the Marlborough Line compared to the Worcester Line.

The above recovery ratios are surprisingly high, yielding a larger percentage of operating expenses covered by fares than would ordinarily be achieved. It should be noted that the analysis was conducted for the extension only and does not reflect the operating cost or revenues of the Framingham service, but the additional costs and revenues of the extension. This may result in higher recovery ratios than would be achieved with a corridor approach. Furthermore, it should be noted that the recovery ratio does not consider capital costs; recall that total annualized costs exceeds the revenues substantially. Finally, while revenues are calculated for year 2010 riders, costs are expressed in 1989 dollars.

8.5 IMPACTS ON OTHER TRAVEL MODES

The vehicle-miles-travelled (VMT) change figures displayed in the table below represent the savings in vehicle-miles-traveled associated with each of the Worcester/ Marlborough/Milford commuter rail alternatives. The bus alternative serves as the baseline for these calculations, and the savings therefore represent the improvement over the bus alternative for each of the rail alternatives. The small difference between Worcester alone (Alternative 1) and the Worcester/Milford combination (Alternative 2) shows that the addition of rail service on the Milford branch does not significantly decrease total VMT. This is also demonstrated by the small difference between the Marlborough/Milford combination (Alternative 3) and Marlborough alone (Alternative 4).

While there is a significant decrease in VMT brought about by rail service to Worcester, rail service on the Marlborough branch has a much larger impact. Many more transit riders in Alternatives 3 and 4 are new to the transit mode when compared to the Bus Alternative than in Alternatives 1 and 2. This difference in impact between the Worcester and Marlborough branches can be understood by looking at the Bus Alternative, against which all the rail alternatives are being measured. In the Bus Alternative, the bus service from Worcester to Boston captures a high proportion of the travellers who use the rail service to Boston in Alternatives 1 and 2. Also in the Bus Alternative, the Marlborough bus captures a much smaller proportion of the travellers who use the Marlborough branch rail service in Alternatives 3 and 4. The result is that, when measured against the Bus Alternative, the rail service on the Marlborough branch in Alternatives 3 and 4 pulls many more travellers to transit from the auto mode than the Worcester rail service in Alternatives 1 and 2.

Alternative	Total VMT	VMT Change
Bus	496,058	---
1 - Worcester	458,404	(37,654)
2 - Worcester/Milford	455,295	(40,763)
3 - Milford/Marlborough	423,960	(72,098)
4 - Marlborough	426,133	(69,925)

8.6 ECONOMIC DEVELOPMENT IMPACTS

Public transportation, in general, is one of several factors which together can influence development. Alone, it may not exert a strong influence, but in association with other factors, it can reinforce existing patterns and contribute to the shape of future growth. Rapid transit, among transit modes, has the greatest potential for influencing economic development due to its high level of service and high ridership.

Information about the economic development impacts of commuter rail service, specifically, is scarce. That which exists suggests such impacts are generally modest and tend to occur in densely developed areas. In Toronto, a small amount of residential and commercial/retail development near one new commuter rail station was seen to be generated by the station. In Philadelphia, service was improved on the existing system and some residential and commercial development was generated near some stations. However, there were no significant development impacts around most stations.

In the Worcester/Milford/Marlborough areas, it is likely that economic development impacts would be confined to increasing some residential property values due to enhanced accessibility to downtown Boston for people who work there. In addition, there is the potential for some modest commercial/retail growth around stations, if supported by local communities. In particular, if ridership levels can support them, convenience retail

TABLE 8-1
SUMMARY OF CAPITAL COSTS(a)
($THOUSANDS)

Category	Alternative No. 1 Worcester Only	Alternative No. 2 Worcester/Milford	Alternative No. 3 Marlborough/Mil.	Alternative No. 4 Marlborough Only
Right of Way Improvements (includes bridges & culverts)	10,909 .0	25,970 .0	27,786 .0	12,968 .0
Stations (b)	20,200 .1	23, 847 .2	21,346 .5	18,943 .8
Rolling Stock ($1.34M trailer, $1.47M control car, $2.3M engine)	34,680 .0 (c)	38,700 .0 (d)	39,790 .0 (e)	41,380 .0 (f)
Subtotal	65,789 .1	88,517 .2	88,922 .5	73,291 .8
Contingency (@20%) (g)	6,221 .8	9,963 .4	9,862 .5	6,382 .4
Engineering (@15%) (h)	4,666 .4	7,472 .6	7,369 .9	4,786 .8
TOTAL	**76,677 .3**	**105,953 .2**	**106,154 .9**	**84,461 .0**

(a) All costs are expressed in 1989 dollars.

(b) Station costs are based on most desirable sites from Table 4-44.

(c) Estimate for 9 trailer cars, 6 control cars and 6 locomotives.

(d) Estimate for 12 trailer cars, 6 control cars and 6 locomotives.

(e) Estimate for 10 trailer cars, 7 control cars and 7 locomotives.

(f) Estimate for 14 trailer cars, 6 control cars and 6 locomotives.

(g) Contingency taken on Right-of-Way Improvement and Station Cost only.

(h) Engineering taken on Right-of-Way Improvement and Station Cost only.

TABLE 8-2
RAIL OPERATING AND MAINTENANCE COSTS

Measure	Alt. 1 Worcester Express	Alt. 2 Worcester Milford	Alt. 3 Marlborough Milford	Alt. 4 Marlborough Express
Service Parameters:				
Revenue Train Miles:				
Extension service	299,504	425,902	358,627	198,197
Framingham service	(77,322)	(165,690)	(165,690)	(77,322)
Net Train Miles	222,182	260,212	192,937	120,875
Revenue Car Miles: [1]				
Extension service	898,408	1,596,673	1,371,282	743,238
Framingham service	(243,012)	(872,634)	(872,634)	(243,012)
Net Car Miles	655,396	724,039	498,648	500,226
Annual IB Passengers	994,140	1,117,750	1,112,490	1,025,700
Framingham Station Passengers [2]	(407,650)	(407,650)	(407,650)	(407,650)
Net Annual Passengers (IB+OB, extension only)	1,172,980	1,420,200	1,409,680	1,236,100
Annual O&M Cost Estimate:				
Annual O&M Cost of New Service (in million $)	$6.33	$11.54	$10.76	$5.58
Annual O&M Cost of Framingham Service (in million $)	$1.25 [3]	$4.47 [4]	$4.47 [4]	$1.25 [3]
Annual O&M Cost of Extension (in million $)	$5.08	$7.07	$6.29	$4.33
Unit Costs of Service:				
Cost Per Passenger	$4.33	$4.98	$4.46	$3.50
Cost/Rev. Train Mile	$22.86	$27.17	$32.60	$35.82

Notes:

[1] Based on revised Framingham service plan which includes mileage to and from South Station, which would not be required for passenger service in the extension plans due to the relocation of storage facilities to outer terminals, despite the addition of peak hour service and route mileage. The revised Framingham service plan is based on shorter trains in off peak hours, resulting in a significant reduction in car miles over current Framingham service.

[2] Framingham boardings forecast for 2010, without any rail extensions.

[3] Cost of existing off-peak Framingham service which would be redundant in this alternative and savings from reductions in Framingham peak consists.

[4] Cost of existing peak and off-peak Framingham service which would be redundant in this alternative.

TABLE 8-3
BUS OPERATING AND MAINTENANCE COSTS

Measure	Bus Alternative	Alternatives 3 and 4 Worcester Express
Revenue Bus Miles	691,637	518,636
Annual IB Passengers	391,870	239,330
Annual Passengers (IB+OB)	783,740	478,660
Annual Bus O&M Cost (Millions)	$1.53	$1.07
Cost Per Passenger	$1.96	$2.23
Cost/Rev. Bus Mi.	$2.22	$2.06
Pass./Rev. Bus Mi.	1.13	0.92

Notes:

[1] Bus service to Milford is terminated in Medway under all Milford rail alternatives. As a result, service to Medway is considered outside of the study area.

[2] No Bus service enhancements are provided under Rail Alternatives.

[3] The only bus service in Alternatives 3 and 4 is the Worcester/Boston Express.

TABLE 8-4
TOTAL OPERATING AND MAINTENANCE COSTS

Measure	Bus Alternative	Alt. 1 Worcester Express	Alt. 2 Worcester Milford	Alt. 3 Marlborough Milford	Alt. 4 Marlborough Express
Passengers:					
Annual Rail Passengers (IB+OB)		1,172,980	1,420,200	1,409,680	1,236,100
Annual Bus Passengers (IB+OB)	783,740	0	0	478,660	478,660
Total Passengers	783,740	1,172,980	1,420,200	1,888,340	1,714,760
O&M Costs:					
Net Rail O&M Cost (in million $)		$5.08	$7.07	$6.29	$4.33
Bus O&M Cost (in million $)	$1.53	$0.00	$0.00	$1.07	$1.07
Total O&M Cost	$1.53	$5.08	$7.07	$7.36	$5.40
Unit Costs:					
Cost Per Passenger	$1.96	$4.33	$4.98	$3.90	$3.15

TABLE 8-5
EXTENSION STATIONS BY FARE ZONE

Station	1989 Zone	Average Fare	Fare
Framingham	5	$2.75	$2.48
Ashland	7	$3.35	$3.02
Westborough	7	$3.35	$3.02
North Grafton	8	$3.60	$3.24
Worcester	10	$4.75	$4.28
East Holliston	6	$3.10	$2.79
Holliston	7	$3.35	$3.02
Milford	8	$3.60	$3.24
Salem End Road	5	$2.75	$2.48
California Avenue	6	$3.10	$2.79
Main St. Southborough	6	$3.10	$2.79
Northboro Rd./I-495	7	$3.35	$3.02

TABLE 8-6
ESTIMATED PASSENGERS AND RESULTING REVENUE FOR RAIL ALTERNATIVES

				ALT 1		ALT 2		ALT 3		ALT 4	
Station	Zone	1989 Fare	Average Fare	One Way Pass.	One Way Revenue	One Way Pass.	One Way Revenue	One Way Pass.	One Way Revenue	One Way Pass.	One Way Revenue
Framingham	5	$2.75	$2.48	923	$2,283	1230	$3,044	990	$2,450	1215	$3,007
Ashland	7	$3.35	$3.02	630	$1,899	360	$1,085				
Westborough	7	$3.35	$3.02	920	$2,774	920	$2,774				
North Grafton	8	$3.60	$3.24	120	$389	120	$389				
Worcester	10	$4.75	$4.28	880	$3,762	880	$3,762				
East Holliston	6	$3.10	$2.79			430	$1,200	460	$1,283		
Holliston	7	$3.35	$3.02			130	$392	150	$452		
Milford	8	$3.60	$3.24			180	$583	180	$583		
Salem End Rd.	5	$2.75	$2.48					810	$2,005	820	$2,030
California Ave.	6	$3.10	$2.79					550	$1,535	550	$1,535
Main St. (S'boro)	6	$3.10	$2.79					180	$502	180	$502
Northboro Rd.	7	$3.35	$3.02					580	$1,749	730	$2,201
Total One Way Daily Revenue					$11,107		$13,229		$8,811		$7,073
Total Round Trip Daily Revenue					$22,214		$26,458		$17,621		$14,147
Total Annual Revenue (263 Weekdays)					$5,842,407		$6,958,507		$4,634,349		$3,720,569
Less Estimated Framingham Revenue Without Extensions (Assumes 1550 Framingham riders in 2010 without extensions)					$2,017,868		$2,017,868		$2,017,868		$2,017,868
Net Extension Revenue					$3,824,538		$4,940,639		$2,616,481		$1,702,701

Average Fare as a Percentage of Cash Fare: 0.9

Note: Under Alternatives 1 and 4, 75 percent of Framingham downtown ridership was allocated to express trains, while 25 percent was allocated to local trains. Framingham ridership shown for Alternatives 1 and 4 is only express riders that would use extension trains. Alternatives 2 and 3 show all Framingham riders, due to the express/local service plan under those alternatives.

TABLE 8-7
LIFE CYCLE COST OF ALTERNATIVES

		Peak Vehicles	"Net*" Peak Vehicles	Annual "Net*" O&M ($ Mil)	Vehicle Cost ($ Mil)	Vehicle Life	Annualized Veh Cost ($ Mil)	Construct Cost ($ Mil)	Structure Life	Annualized Const Cost ($ Mil)	Total Annualized Cost By Mode ($ Mil)	Total Annualized Cost of Alternative ($ Mil)
BUS	Enhanced Bus Service	15	15	$1.5	$3.3	12	$0.5	$1.8	30	$0.2	$2.2	$2.2
1	Worcester Rail	26	21	$5.1	$34.7	25	$3.8 $19.3 $10.3	$12.3 30 100	20 $2.1 $1.0	$1.4	$13.4	$13.4
2	Worcester/Milford Rail	60	24	$7.1	$38.7	25	$4.3 $36.8 $14.9	$15.5 30 100	20 $3.9 $1.5	$1.8	$18.6	$18.6
3	Marlborough/Milford Rail	60	24	$6.3	$39.8	25	$4.4 $43.1 $15.8	$9.1 30 100	20 $4.6 $1.6	$1.1	$17.9	$19.2
3	Worcester Bus	5	5	$1.1	$1.1	12	$0.2	$0.0	30	$0.0	$1.3	
4	Marlborough Rail	31	26	$4.3	$41.4	25	$4.6 $25.9 $11.3	$5.9 30 100	20 $2.7 $1.1	$0.7	$13.4	$14.7
4	Worcester Bus	5	5	$1.1	$1.1	12	$0.2	$0.0	30	$0.0	$1.3	

Notes: UMTA Guidelines specify the following Life Cycle Costs
100 Year Structure Life includes roadbed and land acquisition
30 Year Structure Life includes track, passing sidings, turnouts, communications and signalling systems bridges, stations, layover facilities
20 Year Structure Life includes fencing and grade crossing or traffic signals

25 Year Vehicle Life for rail equipment
12 Year Vehicle Life for bus equipment

*Net means that associated with the extension service area only